# WORLD ENVIRONMENTAL CONSERVATION CONFERENCE

# 2023

# CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH

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## PREFACE

There is a growing concern on the adverse impacts of climate on biodiversity. This phenomenon is greatly manifested in form of shifting weather patterns threatening global food security, health and species existence. Humanity is at the receiving end of the consequences of climate change hence there is a need to step up actions on all fronts- overtime, everywhere all at once.

This calls for collaboration, partnership and networking to strengthening synergy among relevant stakeholders in a bid to tackling climate change menace. This forms the basis for the theme of this year world Environmental conservation conference: **CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH.** The theme is conceived with a view to create an interface for information sharing and offer opportunities for participants to refine their commitments and pledges in the quest to achieving Sustainability in the face of climate change.

This year World Environmental Conservation Conference is memorable in the sense that it received overwhelming funding from the host - West African Science Service on Climate Change and Adapted Land use). WASCAL is posed to provide information and knowledge at the local, national and regional level to cope with the adverse impacts of climate change. Thus, this conference will offer opportunities for participants to learn from good practices demonstrated and showcase by WASCAL during the course of the conference. It will also strengthen staff-student exchange and provide prospect for Doctorate Research Doctoral Research in West Africa Climate System Programme (DRP WACS) – WASCAL among others.

Special appreciation goes to the management of The Federal University of Technology, Akure the host institution, National Park Service and African Regional Center for Space Science and Technology Education-English (ARCSSTE-E) that co-host this conference. We equally acknowledge other private, individual and corporate organizations that have contributed towards the success recorded in this event.

All the submitted articles were subjected to strict double blind peer-review process by the reviewers that are experts in the area of the particular submitted manuscript. The accepted manuscripts are published in WECC 2023 proceedings and also available for download on the organization website (www.necorng.org).

The accepted manuscripts fall within the underlisted subthemes:

- Climate change adaptation strategies in Agriculture, Forestry and Other Land Use (AFOLU)
- Climate smart city and architectural landscape design
- Retrofitting and decarbonization in tourism and hospitality industry
- Indigenous knowledge and local innovation in climate change adaptation
- Climate risk management, health, safety and hygiene
- Carbon credit-offset marketing/circular economy
- ICT development in environmental conservation (image processing and acquisition, computer vision, graphics, speed, interface technology, HMD devices, GIS: Body Tracking, AI and IOT, VRT, IVE).

We commend our keynote speaker Prof. Douda Kone Director Capacity Building Department, WASCAL Headquarter, Ghana and other guest speakers Prof. Babatunde Rabiu, Director General, Chief Executive Office, African Regional Centre for Space Science and Technology Education-English (ARCSSTE-E) and Dr. Goni I. M., Conservator General National Park Service.

*It is hoped that researchers, students and policy makers will find the papers in this book very useful. Even though all the papers were reviewed and edited, the content and option expressed remain essentially that of the authors and not necessarily that of Netlink Environmental Conservation Organization.*

**Dr. Oladeji S. O.**

*President Netlink Environmental Conservation Organization*

*Convener World Environmental Conservation Conference*

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# ADOPTION OF CUSTOMIZED BIODEGRADABLE MULCH FILMS FOR ADVANCING FOOD SECURITY AND SAFETY IN NIGERIA

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## ABSTRACT

*This paper examined the significance of the customized Biodegradable Mulch Films as a safe option to replace syntheticnon-biodegradable plastic mulch films used by farmers in the six-geo-political Zones of Nigeria with a view to reducing pollution generated from plastic mulching activities in Nigerian agricultural systems.Specifically, the application, ecological functions, life-cycle assessment, level of awareness as well as adoption of the Customized Biodegradable Mulch Films were discussed. Moreover, the study also highlighted that agro-wastes from diverse sources of underutilized and neglected food resources in Nigeriaarefeasible sources of thermoplastic starches for the sustainability of BDM production. The study concluded that the Customized Biodegradable Mulch Films is an environmentally-friendly alternative to the conventional synthetic plastic mulch films used by farmers.*

***Keywords:*** *Biodegradable, Plastic Mulch Films, Plastic pollution, Agricultural systems, Thermoplastic starches*

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## INTRODUCTION

Adequate and safe food resources arenecessary for the sustainability of life forms on the planet. Presently, the world is facing a food crisis of a higher magnitude in modern history. It is estimated that about 828 million people out of the 8 billion human population on the planet suffer chronic undernourishment with 345 million people exposed to challenges of unsafe and inadequate food resources (FAO, 2017). According to Onyeaka et al. (2018), the worst hit of people affected are from lower-middle-income countries. Additionally, approximately 3.1 million (45%) of all deaths in young children can be attributed to poor nutrition and consumption of unsafe food resources (FAO, 2017). Africa has been confirmed as one of the hotspots of undernourished people in which Nigeria as the most populous country in Africa suffers the major effects. Moreover, currency depreciation and devaluation triggered the negative impacts of food insecurity in Nigeria as most agricultural inputs are expensive and unaffordable to somefarmers. Thereby, leading to an increase in the cost of food production.A mere one percentage point increase in currency depreciation correlates with a 0.22 percentage point rise in inflation (Ahmed and Yousuf, 2021). In addition, the threat of climate change, environmental pollution, and insecurity are factors triggering for food crises. Consequently, revamping the agricultural technologies and system to increase efficient crop production in addressing food shortage and food safety is one appealing way to achieve the aim of eliminating hunger globally. According to Ezeon et al. (2018), the use of plastic mulch films or plasticulture has been reportedas one of the innovative agricultural technologies that can bring sustainable food systems. Since the year 1960, plastic mulcheshave been used to increase crop yields. This is because it allows for a more consistent and reliable yield throughout the year and minimizes the chances of negative external factors such as infection from disease-causing agents and pests.

Plasti-cultural farming which involves the use of non-degradable Low-Density-Polyethylene (LDPE) plastic films to cultivate crops has gained high popularity over the past three decades in developed and developing countries. Plastic mulch is a modern form of ''agricultural mulch" composed of a continuous and impervious sheet of polyethylene film that provides similar functions to traditional organic mulches. The use of plastic mulch has launched farmers into the world of ''plasticulture''. However, the use of plastic mulch film to cultivate crops releases microplastics and other chemical pollutants into the food chain with devastating consequences; thereby rendering farm produce unsafe for human consumption. Moreover, toxic gases are emitted when burning plastic mulch films on farm after use Muniyasamy and Dada (2021). Likewise, mismanagement of non-degradable mulch films after use can block drainages and fill up land spaces causing land pollution and flooding (Dada, 2020) in which residual fragments of plastic films remain in agricultural soils for 200 to 400 years.
To address this challenge, scientists have suggestedthe introduction of accelerated innovation and improved technologysuch as the use of bioplastics in form of biodegradable mulch films (BDM) across agricultural sectors and other nutritional platforms. Biodegradable mulch films (BDM) have been embraced as a feasible environmentally-friendly alternative to synthetic non-biodegradable plastic mulch film. Biodegradable mulch films have been known to be useful in that it reduces reliance on weather, and skilled labor, as well as conserves the soil moisture contents.

It also gives room to vertical space usage and reduces the need for additional land and construction activity. Moreover, the BDM degrades and enriches the agricultural soil. Thereafter, the remnants of the degrading BDM can be ploughed in by the farmer. Thus, the adoption of

customized biodegradable mulch films (BDM) for natural soil conditions in Sub-Sahara Africa is germane, especially in the Northern and Eastern regions of Nigeria where this technology is lacking and beyond.

Customized biodegradable mulch films are a type of organic mulches that utilize biodegradable films to shield plants from unfavorable environmental conditions. The BDM film is free of toxic moieties as it biodegrades completely into constituents that do not harm the soil ecology or environment as well as prevent weed clusters; thereby reducing landfill waste (Dada, 2020). There is also potential for Greenhouse gas (GHG) emission reduction when BDM is used. Thus, improving the aesthetic nature of the agricultural systems as well as supporting the vision of the circular economy pronounced by the World Economic Forum.

**Problem Analysis in the Nigerian Agricultural Sector**

Agriculture is an important sector for the economic development of any nation both in developed and developing economies. The agricultural sector has the potential springboard for industrial and economic development through employment generation, foreign exchange earnings as well as raw materials for industries. The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of the multifunctional nature of agriculture.

In Nigeria, the agricultural industry provides food and fiber. It is also the primary means of employment for Nigerians, accounting for one-third of both the total gross domestic product (GDP) and 70% of the labor force. A sectoral analysis showed that agricultural output, comprising crop production, livestock, forestry, and fishery, accounted for more than 40% of the GDP in 2015 (CBN, 2015). In the past, the Nigerian government's strategy for stimulating agricultural production was protecting the sector with bans on agricultural imports and subsidies on inputs. However, a number of challenges are facing the agricultural sector in Nigeria. One of such is the challenge of plastic pollution in agricultural soils of Nigeria. Plastic mulch film has been used in the agricultural sector with significant yields of crops grown.

Presently, in Nigeria, the only method of disposal of plastic mulch is by open burning on the farm which releases carcinogenic dioxins that are forty times more toxic than the toxicity released by five-standard incinerator plants. The buried plastics usually get shredded through tillage activities on agricultural landscapes. The detrimental effects of the use of plastic mulch present a great disposal challenge for agricultural communities. Thus, it is importantto opt for a green solution to the ecological challenges of plastic mulch film in agricultural systems in Nigeria. However, there is a dearth of information and documentation on users' environmentally safe approach to the management of plastic mulch film in Nigeria. This recognized environmentally-friendly option to synthetic non-degradable plastic mulch film in natural soil condition will then be publicized for adoption in Nigeria through market analysis, users' requirements, stakeholders' meetings, workshops, focus group discussions as well as production of policy briefs.

**Adoption of the Customized Biodegradable Mulch Films: The Nigerian Experience**

Intensive and sustainable agriculture engages, novel technologies for higher crop productivity and quality without compromising standards. This paradigm shift in farming has become paramount for adoption at all levels (small or large scale). The use of biodegradable mulch (BDM) films is a novel innovative technology in Nigeria. Biodegradable Mulch (BDM) film is a sustainable technology in agricultural production systems. It is yet to be used in Nigeria. The mulch performs equally to non-biodegradable polyethylene mulches(**Plate 1**) and biodegrades completely into constituents that do not harm the soil ecology or environment but increase soil quality. Reduced labour costs for removal and disposaladd further appellation to the sustainability of biodegradable mulch film (Adele et al. 2020)

Customized BDM films for natural soil conditions in agricultural systems is in practical use in some part of the world but the adoption across the African agricultural landscape is slow. The customized BDM is developed by using locally available natural polymers such as starches from agricultural organic wastes and other additives to customize the biodegradation rates of BDM.

**Plate 1:** Tomato Crops under Silver/Black Non-Biodegradable Mulch Film

Presently, on a pilot scale, the BDM is the first bioplastic material developed for use in agricultural systems of Ondo State, Nigeria.
The film is developed by the Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa in collaboration with Elizade University, Ilara-mokin, Ondo State, Nigeria under the Project tagged Sustainable Manufacturing and Environmental Pollution (SMEP) programme using starches obtained from cassava agrowastes. The project has anticipated benefits that are quite feasible and promises huge benefits to agriculture practice in Nigeria. Prior to the launch of BDM films in Nigeria as a form of bioplastic, slight work had been done on bioplastic development while the Federal Government of Nigeria also supported the environmentally-friendly approach of handling the challenges of plastic pollution. For instance, Federal Industrial Research, Oshodi (FIRO) worked on the development of bioplastics from Cassava peels as a source of starch components (Adigun *et al.*, 2015). Moreover, The Federal Government of Nigeria embraces the vision of the World Economic Forum (WEF) on circular economy. Therefore, in the two major Gazettes of the Federal Government of Nigeria, which are the National Policy on Plastic Wastes and the National Policy on Solid Waste Management, bioplastic development or the use of biodegradable materials is one of the strategies highlighted that can be adopted to replace the non-biodegradable plastics in the environment. Moreover, in 2021, Nigeria also embraced the goals of the Global Plastic Action Partnership (GPAP) as well as initiating Project Steering Committee (PSC) for Promotion of Sustainable Plastics Value Chains in 2022. Besides, in the year 2023, Ondo State Government also initiated the production of Bioplastic packaging bags which is fully biodegradable in support of the vision of circular economy and zero-waste initiative of the Federal Executive Council of Nigeria on behalf of the Federal Government.Furthermore, to increase the awareness of BDM in Nigeria, advocacy meetings, Focus Group Discussion (FGD), and interviews among others have been held across the country in some selected states in Nigeria to encourage stakeholders to promote the adoption of the BDM film by increasing farmers' awareness. Presented in Figure 1 is the situation analysis of the level of awareness of the plastic mulch technology in Nigeria before and after the conduct of Advocacy meetings on the customized BDM by Elizade University, Ilara-mokin, Ondo State-Nigeria and the Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa with the South-West zone of Nigeria having the highest level of awareness. Thus, it is germane to encourage the adoption of the BDM among stakeholders in all six geopolitical zones in Nigeria, especially in the Northern region of Nigeria. Stakeholders from global to local levels, across every sector, alongside government donors, Private sector companies, high net-worth individuals and ordinary citizens, youth, influencers, and celebrities can collaborate to reduce the challenge of plastic pollution.Stakeholders such as Policymakers in the Federal Ministry of Agriculture and Rural Development, Federal Ministry of Environment, Agricultural Research Council of Nigeria (ARCN), National Centre for Technology Management (NACETEM), and other Research Institutes among others should be informed and integrated into the advocacy drive for the BDM adoption in Nigeria.

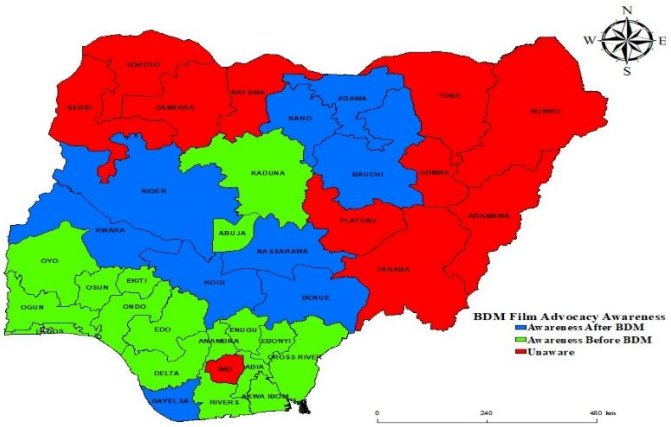


**Figure 1:** Level of Awareness of the BDM Film in Nigeria
**Source:** SMEP Field Data, 2023

Other stakeholders such as farmers, farmers associations, traditional rulers, academics, researchers, agricultural extension officers and Non-Governmental Organizations, Civil defence Agencies among others are relevant stakeholders that can promote the adoption and use of BDM in Nigeria.

**Life Cycle Analysis of Customized Biodegradable Mulch Films**

Life Cycle Analysis (LCA) defines the scope of impact, the specific material flows and their impacts, and improvement strategies for the impacts from a process quantitative life-cycle analysis (LCA). It also enables a better understanding of the environmental impacts of plastic materials in addition with the science of industrial ecology, through the tools of biotechnology (Dada et al., 2023). The customized BDM is biodegradable, environmentally-friendly and sustainable as terrestrial environment sustains the cultivation of renewable resources that are

used to produce them. For example, production of crops with low inputs of water and fertilizer that can be grown on marginal lands, reduces deforestation and pressures on food supplies. When used to cultivate crops, increased yields are reported while after cropping activities, remains of the customized BDM are degraded naturallyat higher degradation rates with the release of water and carbon (iv) oxide (C02). According to Nomadolo et al. (2022), the remnants of the customized BDM can be ploughed into agricultural soils; thereby fertilizing the soil after degradation as well as increasing the cell biomass of the indigenous soil microbial consortia involved in the biodegradation processes.

**Sources of Raw Material Substitutions for the Production of the Customized BDM**

Other wide range of bio-based biodegradable polymers that are renewable resource-based that can be utilized to prepare the Customized biodegradable BDM are Polyhydroxyalkanoates (PHAs), Polylactides (PLA), Cellulose esters, and Thermoplastic starch. The renewable resources are biodegradable and confer biodegradable traits to the biocomposite materials obtained from them. Biodegradation is the process by which organic substances are broken down by microorganisms. The term is often used in relation to ecology, waste management, and environmental remediation (bioremediation). Biodegradable composites which can be easily degraded in the natural environment are gaining public interest and are being developed in a number of research laboratories concerned about the persistence and ecological effects of synthetic plastic in the environment (Wahyuningtyas and Suryanto, 2017). There are opportunities in the next generation of renewable raw materials that are available in diversities and could be easily cultivated for the massive production of green plastic substitutes such as biopolymers. For instance, in the European Union as well as in many diverse agricultural systems and environments throughout the world, including Canada, Argentina, India, and Russia, *Linum usitatissimum* (flax) is a commodity crop grown largely. Flax fiber accounts for less than 2% of world consumption of apparel and industrial textiles, despite the fact that it has a number of unique and beneficial properties. Moreover, Hibiscus cannabinu (kenaf) is grown commercially in the United States and Africa while *Corchorus spp*. (Jute) is from India and Bangladesh and West African countries; while *Cocos nucifera*Coir is produced in the tropical countries of the world, with India accounting for 20% of the total world production. *Agave sisalana* (Sisal) is also widely grown in tropical countries of Africa, the West Indies, and the Far East, with Tanzania and Brazil being the two main producing countries. From these renewable resources starches and fiber can be derived to produce bioplastics such as BDM films. In Nigeria, agrowastes fromsome underutilized crops such as *Gossypium sp.* (cotton), *Manihot ecsulentum* (cassava), *Musa species* (banana species), *Oryza sativa* (rice), zea mays (maize), *Corchorus capsularis* (jute), *Ananus comosus* (Pineapple) and *Xanthosoma sagittifolium* can serve as sources of starches for the production of BDM. Importantly, the tropical environments in Nigeria support the growth of these underutilized and neglected crops.

**CONCLUSION**

The development and use of BDM films is an environmentally green approach to solving the problems caused by the use of recalcitrant pplastic mulches. The use of BDM films are feasible since there are diverse renewable resources that can be used to produce BDM films. Thus, stakeholders will want to accept the development of BDM films as compensate for immediate economic losses associated with synthetic plastic business.

In sustaining the future of BDM films and controlling plastic pollution, the participations of all conceivable stakeholders including governments and civil society organizations are germane. Moreover, the prospects of establishing a bioplastics industry is feasible given the availability of biomass across the globe. Besides there are numerous feedstocks identified for use within local bio-economy as diverse natural capitals of raw materials from non-food crops are present across the globe.To ensure the sustainability of the future of bioplastics such as BDM films, it is important to address major factors such as availability of feedstocks, markets, conversion from feedstock to end-use products, enabling environment and technical expertise.Conclusively, the BDM films industry is a young and innovative sector that would develop to replace synthetic plastics because of their negative impacts.

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