The Global Peace and Food Security; A case study of the Global South and the South Pacific Island Nations

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Preface

Most countries in the Global South, Africa, and Pacific Island have irregular rainfall patterns, with strains of El Niño patterns causing severe food shortages. Plant breeding on grains is non-existent in Pacific Island nations, and the main staple foods are imported rice and wheat, although their prices are exorbitant. Food labelling and marketing of affordable energy grains from conventional and mutational plant breeding programs are fundamental for producers and consumers to establish in the global food trade. Hidden hunger from lack of nutrition from staple diets exist in the marginalised populations in both the Global North and the Global South countries. A new paradigm shift in the agrifood system was modelled to accompany the affordable grain from the regions of the wheat and grain producing countries, deviating from the recent biofortification race to diversification of nutrient sources. This article undertakes critical analysis of despairing gaps between the two populations on grain price affordability and adaptations of the globalising effects.

Key Words; *Plant breeding, Food Security*, *Food losses*, *Nutrition*, *Sustainable farming*

1. Introduction

Many policies are versioned and missioned to trigger and transform socioeconomic aspirations and the agrifood and environmental systems outsmarting individual and oblivious terms. As usual, there are many debates, proposals, and strategies to sustain global peace through the equitable sharing of wealth on domestic, regional, and multilateral forums. Climate change, poverty, and inequality are the defining issues that have been proven to exist in countries in the Global South. One significant driving agenda in the MDGs and SDGs has been the eradication of extreme poverty and hunger from active global participation. All SDGs were aligned to food security and will end by 2030. Having access to sufficient nutrition has been a challenge for different sets of criteria used by policymakers in sustainable resource extraction strategies.

A significant proportion of the achievement in food security was achieved through plant breeding with significant genetic gains in a shorter period of time. More than 70% of the global increase in food production is from plant breeding and selection using effective crop management techniques [1][2]. Grain producers have been driven by market demand for minerals and oil content, hence less or no effort has been made on grain crops that are much needed in developing third world nations. Advanced research on increased protein concentrations in wheat without grain yield reduction was undertaken by Monaghan *et al*[3]. However, protein content is more influenced by genotype(G), environment(E), and genotype and environment interactions (GxE)[4][5]. Increasing yield is a multidisciplinary effort from breeding of desired traits to agronomic practices. A classic example of this paper is yield improvement of wheat and maize from irrigation, which is now focused on yield, milling and postharvest advantages.

While not disputing the nutrition enrichment in the rural households from biofortified rice such as the "Golden Rice" in South East Asia, Ginkel and Cherfas[6] still characterized that biofortification had risks of yield penalty and had risks of genetic uniformity on the crops. Furthermore, Golden rice as a GMO crop has not gone well with the populations of rice-growing countries such as the Philippines. In contrast, recent advanced food breeding programs such as the Double-Haploid production technologies (anther culture and maize induction systems) on wheat [7][8][9] and F1 Heterosis on rice[10][11][12] have maintained the equilibrium of the food to population ratio.

Fine arts and poets often stream global food security and run parallel to global peace. Climate change and food security are two eminent threats affecting the livelihoods of Pacific Island nations. Specialized plant breeding as a food aid program was expected to flourish in the Global South supply chain using the gravity model [13] naturally used by the WTO to facilitate trade, such as Helpman and Grugman's model of monopolistic competition [13, 14] and Heckscher–Ohlin's model of specialization [15][16]. The stages of the globalisation and its effects is curtailed in this article on how the communities were adapting on interesting research topics; nutrition availability, affordability of imported grains, transport and stakeholder responsibilities on nutrition, non-communicable diseases, and climate change refugees.

2. Alternative cheap and affordable wheat and grain supply

The lifestyles and eating habits of Pacific Island Nations have changed since the introduction of rice and wheat. More populations have also congregated in towns and cities; hence, there is a demand for imported rice and wheat. Domestic energy crops, such as kaukau, taro, yam, and banana, were sold to buy rice and wheat as a treatment and luxury. Life in the small and remote islands and the atolls was quite cranky, with bread fruit and banana as the main staple food. Overall, food crops are threatened by prolonged dry seasons (El Niño) and rising sea levels; hence, there is an increased need for imported foods. The populations in some island nations were judicious about their dietary contents, and the current source of wheat and grains cannot be replaced. In Papua New Guinea, 10 kg of wheat flour costs US$16.84; but however a second price of US$7.77 in the market with proper nutrition labelling, was yet to be tested. The inhabitants of most Pacific Island nations are known to eat foods that are processed in fats and high sugar [17], with little or no nutrition policy and substantive resilient food security programs. Obesity, diabetes, hypertension and cerebrovascular diseases were common cause of premature deaths [18][19]. Some deaths were exacerbated by climate change-induced food shortages coupled with delayed and high transport costs. With no constant supply of food, eating habits were systematically accustomed to the availability of food (passed on from non-refrigeration times), hence the new paradigm shift for constant food supply with alternative nutrient sources and price affordability.

Food pricing is critical at the moment where the world population is expected to rise from 7.2 billion to 9.6 billion and 12.3 billion in 2100[20]. Although population growth in countries such as China and developed nations was aging and stagnant, much of the population growth was expected in Africa and developing nations where fertility rates were higher [21][22].

The outlook is, however, different from the world population growth projections, especially in sub-Saharan African nations where debilitating weather-induced and conflict-related food crises were evidenced by alarming widespread hunger and chronic malnutrition [23]. A recent example of shock on the population was Covid 19 with it's new strains every three to four months, prompting stringent and cohesive analysis of climate change and its effects. Here, it may only appear that the horizons of the time phase have gone past human perseverance.

3. What has happened to biofortification; A key factor designed to alleviate the hidden hunger from insufficient nutrition in staple crops

New trends of extra input of labor and resources such as availability of land, heavy fertilizer and pesticide use, soil degradation, low yields, and ecosystem imbalances during the biofortification process have prompted other parameters to enable sufficient nutrition for the population. Insufficient intake or lack of vital nutrients such as vitamin A, iron, zinc, and folate in the main energy crops are known to cause malnutrition[24][25][26][27][28], especially in marginalized populations now considered as hidden hunger. The National Government of Papua New Guinea chose to fortify rice to alleviate nutrient deficiency as a national nutrition enhancement policy but was seen as a forced feeding to the public. The usual norm of agronomic biofortification from soil, such as zinc derived from NPK and organic fertilizers[29], has equal benefits on both yield and nutritional quality with consumer satisfaction. Trends in consumer sustenance are significant in agronomic practices.

With improvements in recent rDNA technologies, genetic biofortification of staple crops has been shown to be an effective strategy for increasing dietary Fe and Zn intake [30]. In some regions, such as the European Union, farmers are few in number but are known to be highly productive without GMO crops[31]. EU countries categorize mutants as non GMO from inserted recombinant DNAs. Gene editing via SDN appears promising, with newly generated INDELs remaining indistinguishable from natural mutations, providing accelerated opportunities for specific plant breeding. Ground breaking research using SNAi gene editing technology was undertaken by Garcia-Molina et al.[32] from the Institute for Sustainable Agriculture(Spain) and the University of Tuscia(Italy) to reduce immunogenic gluten. Gluten is a major determinant of bread-making quality but is related to digestive disorders that are significant criteria during wheat breeding and selection. In wheat and oats, β-glucan is known to lower blood cholesterol, an enzyme known to disrupt the gluten network in dough.

Yield as usual is the fundamental issue in biofortification compensation, as described by Ginkel and Cherfas[6] for wheat and Jan[33] for sweet potato. The two candidates of wheat that were introgressed for iron and zinc from high-yielding cultivars were found to be lower in the check cultivar by 82% and 72%, respectively[6]. In sweet potato, two yellow types high in Beta Carotene performed lower yields of 77% and 67%, respectively, from the white low beta carotene check variety[33]. Annual genetic gains from the two species tested ranged from 0.5 to 1%. Here, the need to allocate land for other nutritious vegetables decreases to

accommodate the low yield of bio-fortified staple crops. Food policymakers have now been challenged to give equal attention to nutrient diversification in diets[34][35].

4. Controlled Environment Agriculture (CEA); A potential successful nutrition policy in the Global South

The CEA program is assumed to be the only modern and successful food production technique that meets all the 17 SDGs and the five key take-way action plans in the Cop 28[2023] held in Dubai to keep the temperature goal of 1.5 °C alive[unfccc.int/cop28]. Primary food producers such as Australia were too small to be food bowls for Asia and the Pacific because the current production could feed up to 60 million people [36]. In South America, Brazil proved to be an emerging economy based on agriculture, but faced external pressures from deforestation [37][38][39][40] with periods of economic decline and societal disaffection[41][42]. Recently, Digital Agriculture aimed at precision and smart farming was seen as a new shift of transformative force in food production [43][44][45] at lower labour costs [46][47] and improved health and safety issues[48][49]. A significant food security and trade efficient CEA project was undertaken by the provincial governments of Papua New Guinea in partnership with the LR Group, which is now supplying the domestic fruit and vegetable market, including neighbouring South Pacific Island countries(https://www.innovative-agro.com/9-mile-farm]. Apparently, this project is aggregated into financial benefits at equal prices from local farmers and Fresh Produce Agencies with no CEA competition.

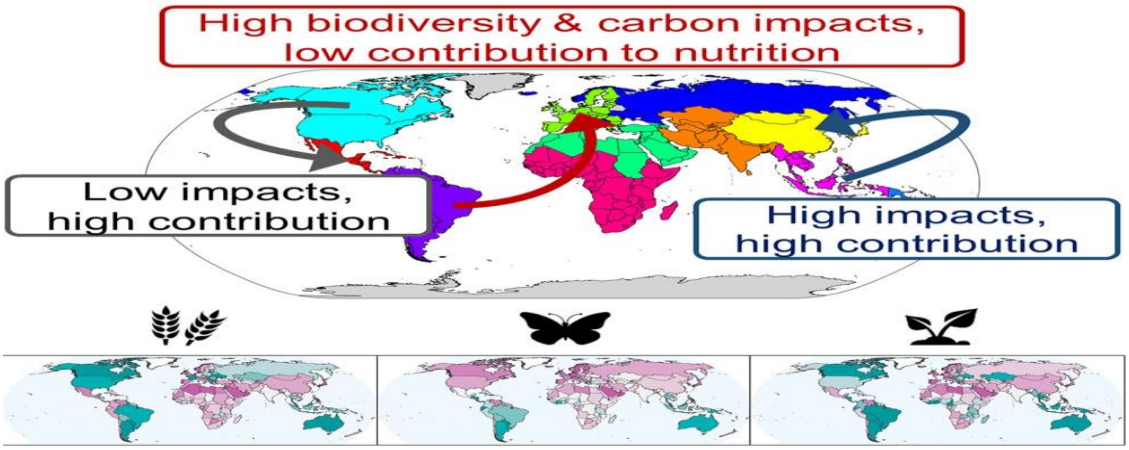
4.1 The Propensity of CEA on the atoll Nations of the Pacific Islands

There is limited literature on how atoll nations cope with environmental and climate change hazards[50,51,52]. Cauchi et al.[50] further stressed the significance of livelihood assets in coping with environmental and social hazards. The necessary concern and priorities of the communities were a significant approach to solving climate change-induced challenges by local governments and concerned stakeholders. The Director of the Secretariat of the Pacific Regional Environmental Programme (SPREP) made an explicit reference where uncertain scientific, social, and environmental concepts cannot be aided by local governments and regional forums[53], a significant step toward climate change adaptation policy. One of the social concerns among Pacific Island countries is the epidemic of non-communicable diseases such as diabetes [17,18,19,54,55]. A significant step in optimizing diabetes management is glucose monitoring[56,57]. Uuh-Narvaez and Segura-Campos[58] found that cabbage had multi-target effects on glucose homeostatic regulation owing to its high content of bioactive compounds. Recent innovations in soil being made in cubes for farming have taken precedence in the small atoll nations on vegetable farming, including staple foods such as Swamp Taro(*Cyrtosperma merkusii*)(https://www.spc.int/updates/blog/partners/2021/10/atoll-nation-of-tuvalu-adopts-cubes-to-step-up-nutritious-food).

5. Ecosystem, Livelihood and Nutrition

Alpaca, a new upland livestock that is popular worldwide, has been a mainstay for rural households of the Andes in South America for meat, milk, and fibre, a case representing most village communities in the Global South on nutrition supplementation. Little is known about the cash economy in these communities, and they have struggled to respond adaptively to economic and institutional globalization[59]. The reason being them living alongside the functional ecology where theoretical and empirical evolutionary processes of the population dynamics, communities, and ecosystems were affluent[59,60,61]. An accessible food policy program promoting livelihoods and conservation was described by Salasky and Wollenberg [62] for rural communities. In contrast, highly anthropocentric means have been proven to be in-adequate for clinical nutrition[63]. Richardson[64] identified that food security were categorized in three definitions; “availability, access and utilization” with a sustainable theme to Integrate human health with the health of the biosphere[59,62,63,64,65]. Globalization and the Agri-food system were now connected in a heterogenous phenomenon termed “telecoupling” between the Global North and the Global South [66,67]; for example due to high demand for pork, Germany ordered tonnes of soyabean from Brazil leading to high level of deforestation. Trade alone cannot offset hunger and nutrition; where Kastner et al.[68] and Clark et al.[69] pointed out that an increased supply of foods such as corn, soybeans, sugar, and meat products is linked to obesity. Threads of practical occultism and self-realism [70] were critical in this review on issues of nutrition, freshwater use, biochemical cycles, livelihoods, ecosystems, and human development.

Figure 1 The highly heterogeneous land use systems amongst trading parties revealing synergies and trade-offs of enhanced nutrition and environmental conservation.[https://doi.org/10.1016/j.oneear.2021.09.006][Kastner et al 2021]



6. Sustainable fisheries development aiding food security in the Pacific Island Nations

For atoll nations in the Pacific, farming is mostly improbable because arable lands are salty and waterlogged by rising sea levels [https://stories.undp.org/food-security-in-the-pacific#!]. During the Pacific Tuna Forum presentation held in Port Moresby in 4th January 2024, the total catch reported for 2022 in the Central and Western Pacific Ocean were around 2.7 million metric tones worth US$5.9 billion[thenational.com.pg/pacific-contributes][http://ptf.infofish.org/]. With such lucrative income, land-based policy directives and in-depth analysis of proactive food security programs supported by tangible budgets by member nations from the Tuna Fisheries were not stressed, but had aggravated allowance for donor support programs, leaving the sinking atoll nations in a precarious position. Several cases of climate change refugees with developed nations such as Australia, New Zealand, and the USA had no legality since the United Nations Convention of 1951 on refugee status declared that no persecution was found on the sinking Island Nations. The current development donor partners were nations that were currently leading the GHGs emissions; hence, the new superficial and resounding Pacific way of leading the global front has emerged by sustaining the existence of the sinking island nations by themselves and the Members of the Pacific Island Forum by fortifying land for housing and farming from the pursuit of sustainable fisheries development.

7. The significance of food transport sector; A sector responsible for postharvest quality to minimize food and nutrition loss

The food transport sector is an efficient and effective method for delivering food from farms to forks in its original and intended purpose for manufacturing, consumption, and stockfeed. Sobal et al.[71] proposed an integrated model of a food system with three subsystems(producer, consumer, and nutrition) and we identified six stages; (breeding, production, manufacturing, transportation, digestion, and metabolism). The six stages were corrected from the nine stages by Sobal et al.[71] in the order of scientific basis and social acceptance.

A fragile vegetables, such as broccoli, have a high nutritional content but quickly decompose during postharvest, shipment, and storage[72], a phenomenon on all fruits and vegetables. Antioxidant and anti-inflammatory properties, such as phenolic compounds, are known to increase during postharvest storage and treatment, but also at the cost of decreased juice yield and marketing value [73]. The transport sector played a pivotal role for both producers and consumers in maintaining commercial quality and quantity. Pest and disease treatment in the tested conditions during transportation in both thermal heat and freezing were necessary to avoid time taken during onshore treatments and to increase shelf life. Online processing and transmission of food import and export permits were required because fast and efficient communication was lacking between the shipping routes that are believed to have caused food losses in shipper's warehouses or losses en route to the destination.

Figure 2 Concentration of Domestic food losses across the globe from 2007 to 2022[https://www.fao.org/platform-food-loss-waste/flw-data/en/]

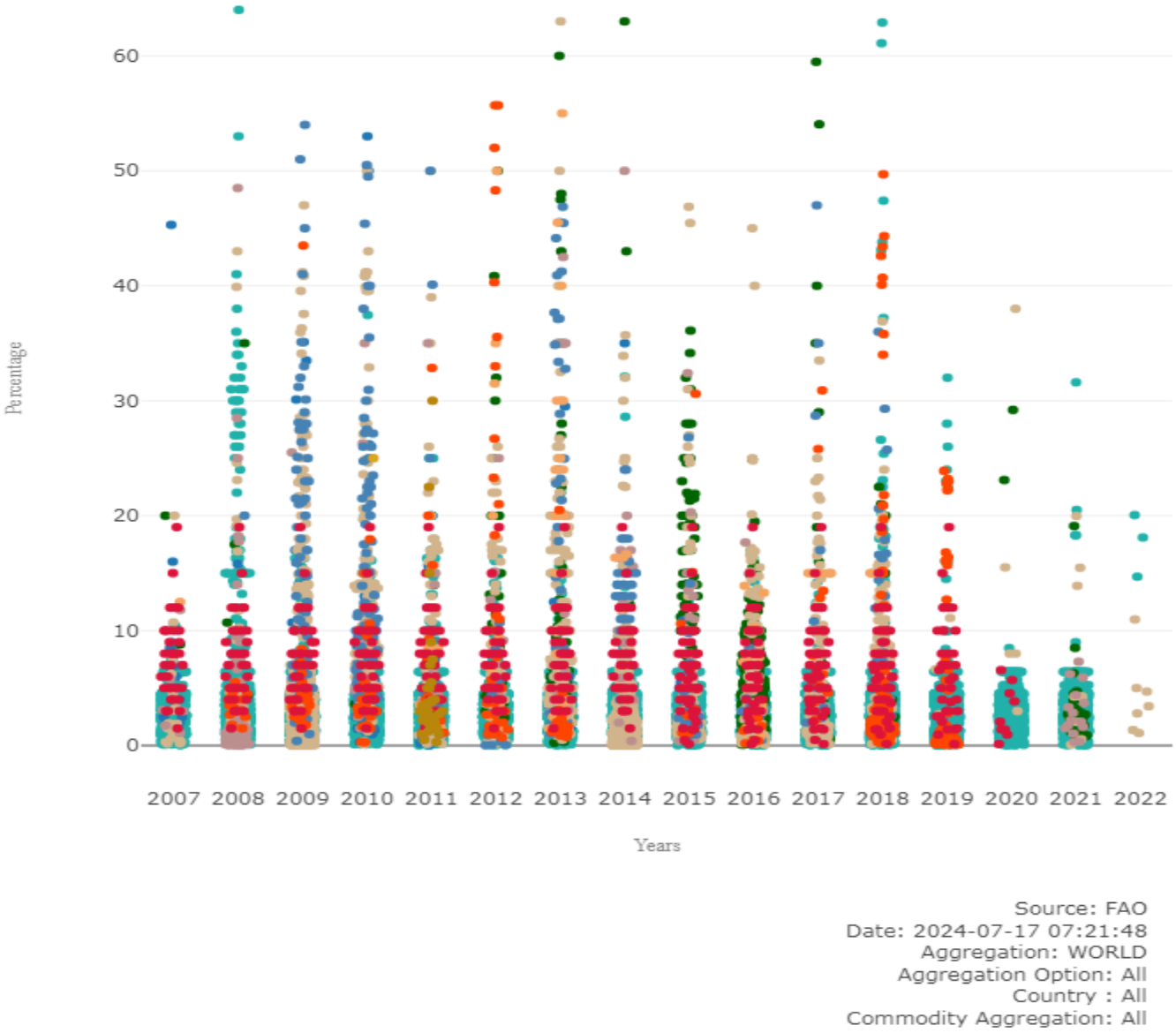
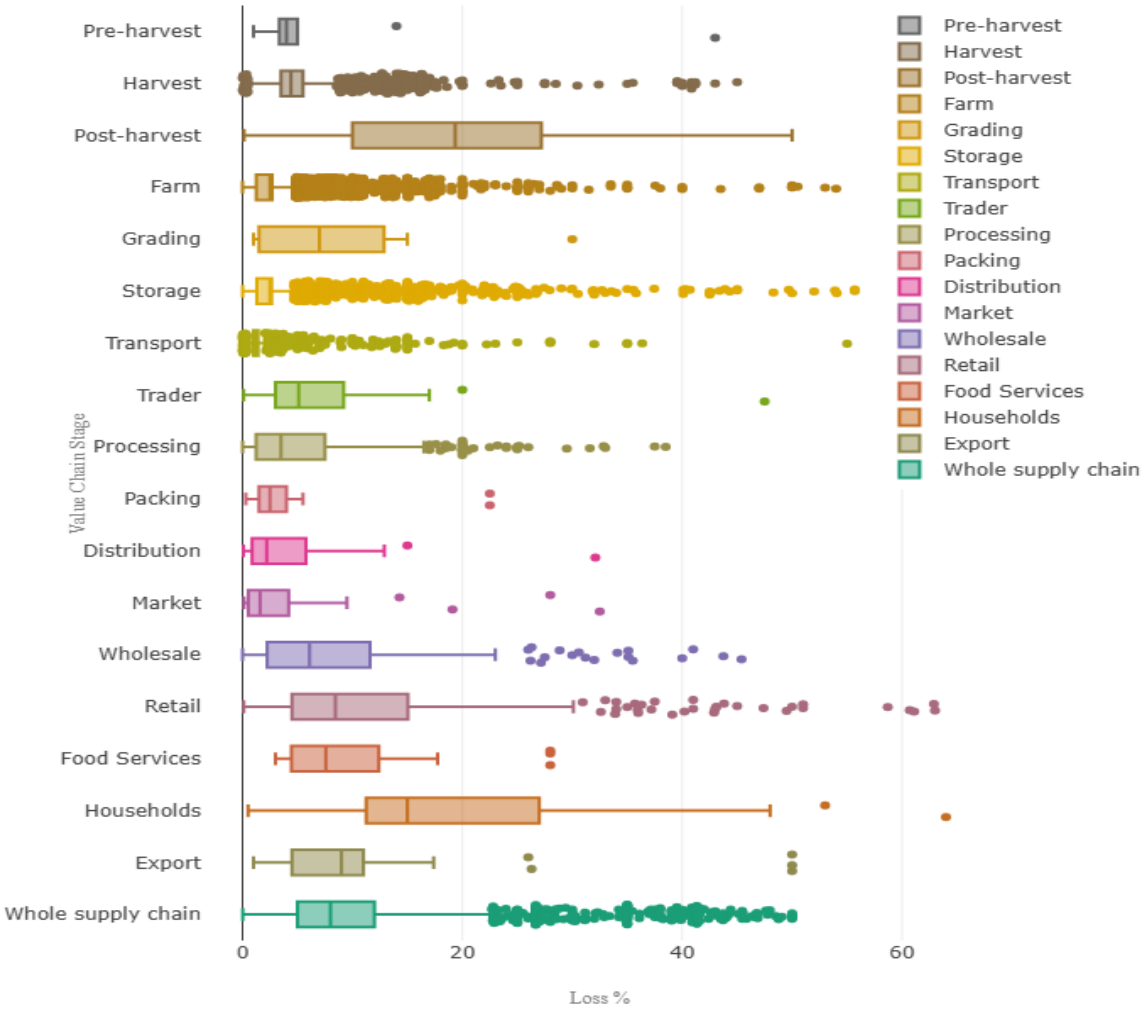


Figure 3 Box plot by stages of domestic food losses across the globe from 2007 to 2022[https://www.fao.org/platform-food-loss-waste/flw-data/en/]



7.1 The Role of Agriculture Quarantine Services in the Transport Sector

Travelling passengers, food movement, raw products, and used equipment are known to spread economic pests, invasive species, and diseases worldwide, threatening food security and livelihood causing government expenditures in billions of dollars. Trading partners are members of the World Trade Organization that comply with the Sanitary and Phytosanitary measures set by the International Plant Protection Convention(IPPC)[74]. Therefore, Plant Quarantine services were not an unreasonable technical barrier to trade, but all policies were based on manageable risks based on science through Pest Risk Analysis [74,75,76]. After compartmentalizing and PRA, trade occurred between parties, guided by the International Standards for Phytosanitary Measures (ISPM)[https://www.ippc.int/en/core-activities/standards-setting/ispms/].

8. Conclusion

The new narration deviating from the biofortification to diversification factored by the food aid program signifies new dimensions of the Agrifood systems, shedding a bright future on land and ecosystem maintenance. With collective efforts in fundamental research on identifying local high yielding grain crops, strategic food security policies are required to resuscitate volatile and fragile nations in the Global South. The struggle and story of the atoll nations in the Pacific reverberates global peace, although direct mitigations such as specific plant breeding for food aid and CEA programs could also stabilize the challenges.

Specific rice grown for Papua New Guinea has preceded with growers in Asia.

The article solves SDGs No.2[Zero hunger]

9. Declaration

The writing is solely for humanitarian and food security purposes upon the critical assessment of sustainable and efficient food production systems. The author is a biosecurity officer at the National Agriculture Quarantine of Papua New Guinea, Graduating as Master of Research-Agriculture(IBERS online) with Aberystwyth University.

AI was used to correct sentence structures

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11.Appendix (1) Websites were reviewed on reviewable sites

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