International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

ACHIEVING FOOD SUFFICIENCY IN 2030 AND BEYOND: THE FUTURE OF ALTERNATIVE FOOD CROPS AND PERI-URBAN AREAS IN DISTRICT 1, ZAMBOANGA CITY, PHILIPPINES

[1*]DAEL, R.R., [2]MINSIONG, T.L., [3]TABAL, E.P. AND [4]BENDIJO, S.A.

[1,2]Graduate students, College of Agriculture, Western Mindanao State University, Zamboanga City, Philippines.

[3,4]Faculty, Graduate School, College of Agriculture, Western Mindanao State University, Zamboanga City, Philippines.

*Corresponding Author

DOI: https://doi.org/10.51193/IJAER.2026.12313

Received: 05 May 2026 / Accepted: 20 May 2026 / Published: 23 Jun. 2026

ABSTRACT

Zamboanga City's agricultural sector currently faces the daunting task of feeding more than 1.0 million residents amidst a critical rice collapse to just 13% sufficiency rate resulting to high rice importation rates sourced from neighbouring provinces and abroad. Aggressive land use changes (LUCs) and land conversion (LCs) for residential and industrial expansion has created a monthly deficit of 9,011.0 mt, or this is 300.34 mt day-1 of milled rice, necessitating a shift toward alternative caloric food crops (ACFCs). This study evaluates the potential of peri-urban areas for ACFCs within District 1, Zamboanga City, Philippines, an area that houses 143,047 people (28,609 households). Using a descriptive research design through a structured questionnaire and purposive sampling procedure, results indicate that 43.5% (3,148.3 has) of the combined areas remain potential zone for agriculture with high potential utilization for growing ACFCs. However, only 14% of this available land is currently utilized for food production, suggesting significant resource under-optimization. The production of alternative caloric staples such as corn, cassava, banana, and sweet potato yielded a cumulative of 2,831.3 mt cropping-1. Corn dominates this output at 38.2% (1,081.6 mt), followed by cassava 34.0% (962.6 mt), banana 26.7% (756.0 mt), and sweet potato 1.1% (31.1 mt) with higher yield and caloric content than rice. Forward-looking linear optimization modelling reveals that achieving full 100% resource utilization of these available lands by 2030 could expand alternate carbohydrate yields up to 20,223.21 mt per season, systematically insulating the district against external supply chain failures. Achieving food sufficiency by 2030 and beyond maybe supported through land-crop suitability analysis, at the

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

same time protecting the remaining agricultural sub-zones from further urban encroachment. Strengthening rural-urban partnerships and promoting climate-resilient cultivars remain the most viable pathways for stabilizing Zamboanga City's future food systems.

Keywords: Food security, alternative food crops, caloric energy, Zamboanga City, Philippines

1. INTRODUCTION

One of the fundamental necessities is food, which provides the daily intake required for survival. The National Food Research Institute (NFRI) measured the average daily caloric requirement of 2,000 kcal person^{-1} day^{-1}. However, producing this caloric output requires an enormous energy inputs [1][2] and land areas to produce the needed food requirement for the 1.078 M people of Zamboanga City, Philippines *(computed at 1.97% Annual Growth Rate, PSA, 2020 data),* where 86.6% (0.94 M or 235,000 households) of the population resides in urbanized barangays *(based on the City Ordinance No. 532, s2019),* and estimated to have a demand of 118.0 kg of milled rice and 67.5 kg of assorted vegetables *(computed from 70.3 kg ppc),* respectively, for the current population across the 98 barangays [3]. The impending progressive population boom would further result in a significant demand for food to meet the population's consumption requirements and the equivalent land, is creating unprecedented pressure on agricultural systems by simultaneously increasing the demand for food and reducing the land available for production. Rapid urbanization, infrastructure development, and industrialization are driving widespread land use changes (LUCs) and land conversion (LC), directly converting prime agricultural land into non-agricultural uses, which threatens long-term food security – substantial conversion from land's most fundamental use (food production and availability) to built-up expansions [4], such as settlements/residential, commercial, and industrial (canning factories and fishing companies, hospitals, schools and shopping centers). Infrastructure projects roads, bridges/skyways, and airports [5][6], will result from apparent land deficit to food insecurity.

Food insecurity perhaps is due to the country's food insufficiency prominently its main staple food – ***"rice"***, which accounts Filipino diet with an annual per capita consumption (pcc) of 118.0 kg person^{-1} to suffice the average caloric requirement of 2,000 kcal day^{-1} for a standard Filipino individual [7-9]. Data showed that the annual average rice production in Zamboanga City is only 28,018.17 mt, from the area harvested of 6,548.99 hectares (ave. yield of 4.28 mt ha^{-1}) comprised of a combined irrigated, rainfed, and upland ecosystems in 2022 [10]. In 2023, average rice sufficiency ratio significantly decreased to less than 13.0%, vegetables and fruits combined are 40%, respectively, while the remaining 60% is imported from across neighbouring municipalities and provinces in Mindanao [11][12]. This insufficiency and imbalance are unachievable in meeting the domestic demand.

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

Rapid urbanization poses significant challenges to food security, hence, to achieve food sufficiency, it is important to increase and strengthen local food production by growing alternative/substitute caloric food crops. Having a Rice Sufficiency Ratio (RSR) of <13% in a traditional rice-eating population, producing alternative caloric food crops (ACFCs) is the means to suffice the progressing caloric demands. Reliance on a single crop would only make the rice system vulnerable to various factors affecting rice sufficiency. Hence, diversifying various caloric food crops can mitigate the risk and provide opportunities for food security [13]. This vulnerability mirrors global agricultural trends; contemporary international literature confirms that uncontrolled urban growth continuously degrades peripheral food basins, forcing dependency on extended, vulnerable distribution channels (Song et al., 2023; Ayambire et al., 2019). Shifting the types of caloric food preferences person-1 would increase food choices and availability, improving the typical Filipino diet to nutrient-rich supplements, such as corn grits, locally known as "*bugas-mais*," believed to have more energy available compared to rice.

Cooked bananas and taro (cocoyam or "tumon, *local name*") are also good sources of protein and energy. Cassava, sweet potato, and banana can be an alternative or supplemental source of carbohydrates instead of rice to create a new food rotation as suggested by the Philippine Rice Research Institute (PhilRice) [14]. Moreover, to withstand difficult growing conditions and have long-term storability underground, root vegetables, cassava, taro, and potatoes are the future reliable supply of good-quality alternatives [15][16], their resilient capacity and resistance to climatic shocks, being underground crops. Perhaps, it may lower the cultural management to the total cost of production. Leading poor urban dwellers, vulnerable to rapid changes in food prices, to avail of cheaper and healthier caloric food crops [17].

Hence, there should be an efficient strategy to make use of the vast and potential agricultural sub-zone in the city potential for growing caloric food crops for a better volume and quality production with low management cost, sustaining the demands of the ever-increasing population in Zamboanga City. Therefore, a significant step to generate production strategies aligned to zoning and urban agriculture ordinances in tapping major non-rice alternative food crops, determine the area and volume of production in selected barangays within the Peri-urban areas in District 1, Zamboanga City, Philippines.

2. MATERIALS AND METHODS

2.1 Study sites

The study was conducted in selected Barangays within the Peri-urban areas namely: *La Paz, Sinunuc, Maasin, Recodo, Cawit, Ayala, Tulungatung, Talisayan, Pamucutan and Sinubong* (Figure 1). These urban barangays were identified based on their areas with major alternative food crops, which were the focused of the study.

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

2.2 Respondents and instrument

A formal letter of invitation was sent to notify the barangays and offices concerned regarding the overview and objectives of the study, and what specific data needed for collections. The Barangay Chairman, Barangay Secretary, and the Chair, Committee on Agriculture from each of the identified barangays were designated as primary respondents, making a total of 30 participants. To augment the main data and expand structural insights across institutional scales, technical experts were integrated as key stakeholders from the City Planning Division Office, Agricultural Field Office II, and the Engineering Division both from the Office of the City Agriculturist, Agricultural Technicians, Traders, hence a cumulative sample size of 35 respondents to enable a thorough investigation of the research objectives. During the interview, the Barangay Chairman, Barangay Secretary and the Committee chair on Agriculture were present to answer the interview for 15-20 minutes, while for the three (5) local offices were delivered via email.

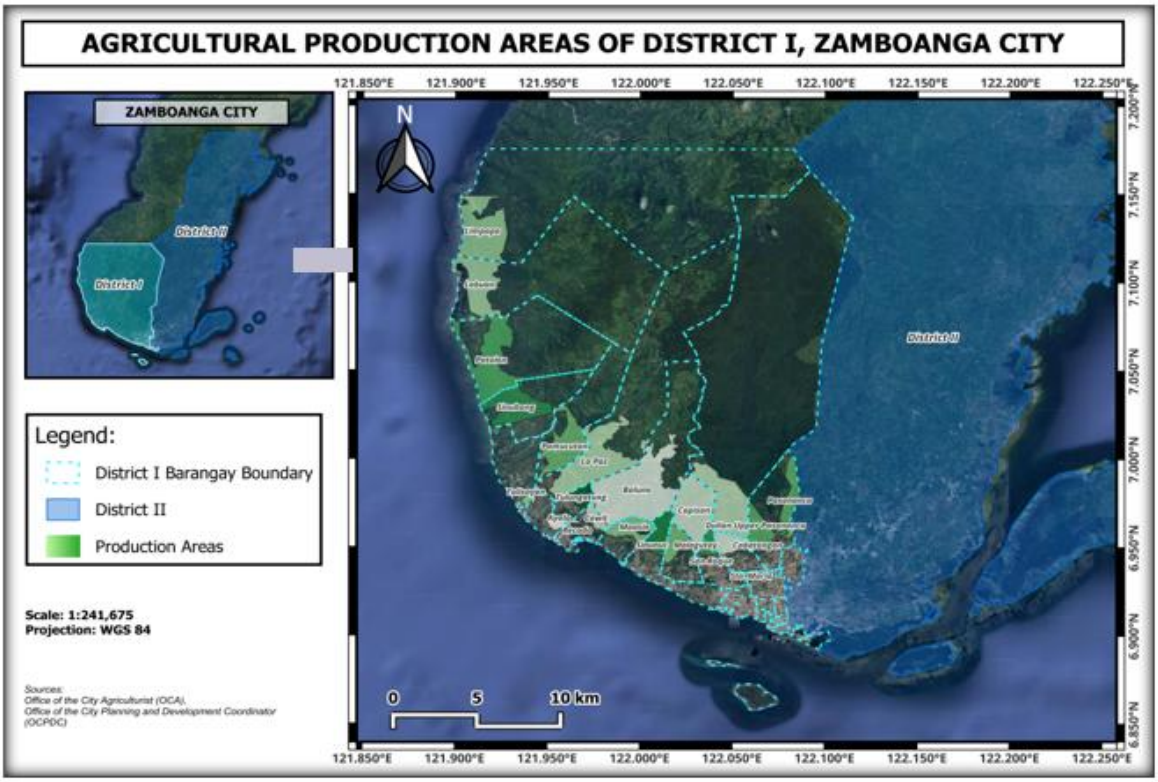

Figure 1: Map of study sites.

2.3 Sampling and statistics

Purposive sampling was employed to select the respondents across the 10 peri-urban barangays and the three (3) local offices to ensure data accuracy. Descriptive statistics were applied to analyze

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

the gathered data, focusing on numerical estimates to identify current population trends, total land area barangay^{-1}, and the specific extent of available agricultural and production areas. Furthermore, this statistical approach facilitated the identification and yield analysis of major non-rice alternative food crops (ACFCs) currently cultivated within the selected peri-urban barangays of District 1, Zamboanga City. Means, percentages, and sums were compared and discussed the variability.

While on-site biophysical plot sampling and soil suitability experiments were bounded by administrative constraints, structural validation of data was enhanced through spatial boundary verification. To strengthen spatial validation, the Spatial Utilization Index (SUI) was employed to quantitatively assess the relationship between agricultural land allocation and current production patterns across peri-urban barangays. The index enabled spatial comparison of land-use efficiency relative to zoning classifications and projected agricultural utilization scenarios.

3. RESULTS AND DISCUSSIONS

3.1 Population, land area and available agricultural lands barangay^{-1}

Table 1 shows the estimated population, land area and available lands for agriculture barangay^{-1} based on the combined data collected from the corresponding barangays and the Office of the City Agriculturist (OCA), Zamboanga City, Philippines.

Table 1: Population, total land area, available agricultural land area per barangay

Barangay	Population[1/]	LA[2/] (has)	ALA[2/] (has)
Ayala	28,822	539.29	74.67
Recodo	25,141	183.86	14.11
Sinunuc	24,777	773.7	281.92
Tulungatung	12,693	237.59	149.89
Talisayan	12,356	1,541.63	33.88
Cawit	11,076	375.14	139.86
Maasin	10,020	520.13	260.95
La Paz	9,508	1,729.27	1,090.40
Pamucutan	4,761	545.67	404.03
Sinubong	3,893	715.7	618.6
TOTAL	**143,047**	**7,161.98**	**3,148.31**

ALA, available land area, City Planning, Zamboanga City.

LA, land area.

[1/]Computed population based on Annual Growth Rate (AGR) of 1.97%, PSA, 2024.

[2/]City Planning and Development Office, Zamboanga City.

Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

Barangays Ayala and Recodo are the most densely inhabited peri-urban areas, with population of 28,822 and 25,141 individuals, respectively, contributing 20.1 and 17.6% of the total population of the 10 barangays combined (Table 1). This population density is largely influenced by the strong industrial sector in these areas, which accommodate significant canning and fishing enterprises, shipbuilding services, and sardine processing facilities. Ayala's industrial production substantially enhances Zamboanga City's status as the ***"sardine Capital of the Philippines."*** These economic engines created significant employment centers and opportunities for surrounding communities, drawing a continuous stream of residents in search of job opportunities.

While, barangay Sinunuc has a population of 24,777 or this is 17.3% share (Table 1). The elevated density is attributed to its physical position as the principal peri-urban gateway, located directly adjacent to the urban core within the 7.0 km radius of the city center. The barangays of Tulungatung, Talisayan, Cawit, Maasin, and La Paz with proximity around 13.9 to 18.2 km from the city center, displayed a modest population counts between 12,693 and 9,508. The two remote barangays, Pamucutan and Sinubong (situated 20.50–27.0 km from the city proper), exhibited the lowest population densities in the area, being close to rural barangays of Patalon, Labuan and Limpapa, all located in the Westcoast.

On land distribution, barangay La Paz – popularly referred to as the ***"Little Baguio of Zamboanga"*** – possesses the largest total land area at 1,729.27 hectares (Table 1). This barangay, with altitudes reaching up to 1,500 meters above sea level (masl), is particularly suitable for high-value crops cultivation. Based on the Proposed Zoning Ordinance (2019-38), La Paz is designated within the Industrial Forest Plantation Sub-Zone (IFP-SZ), Production Agricultural Sub-Zone (PTA-SZ), and the Network of Protected Areas for Agriculture and Agro-Industrial Development (NPAAAD). While, barangay Talisayan, encompassing 1,541.63 hectares (Table 1), is classified as a Production Agricultural Sub-Zone (PTA-SZ) and Agri-Industrial Zone (AgIndZ), underscoring its significance in promoting sustainable agricultural development and effective food production to meet local demands.

In terms of land utilization for agricultural production, Table 1 suggests significant variations in both the extent and the proportion of land dedicated to farming across the studied barangays. Barangay La Paz possesses the most extensive agricultural landscape, encompassing 1,090.4 hectares, which constitutes 63.05% of its total land area. While barangays Sinubong and Pamucutan have smaller absolute areas with 618.6 and 404.03 has, respectively (Table 1), these barangays exhibited the highest relative agricultural density, with 86.43 and 74.04% of their respective territories dedicated to agricultural use.

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

In the mid-range of land utilization, barangays Sinunuc accounts for 281.92 has (36.44%), Maasin 260.95 has (50.17%), and Tulungatung 149.89 has (63.09%). Barangay Cawit maintains 139.86 has, representing 37.28% of its total land area (Table 1).

The highly industrialized and densely populated barangays show the lowest agricultural land retention. Barangay Ayala allocates only 74.67 has (13.85%) to agriculture, while barangay Talisayan – despite its large total land area – dedicates only 33.88 has (2.20%) to production. While barangay Recodo maintains the smallest agricultural area at 14.11 has (7.67%) of its total land area (Table 1). These disparities highlight the pressure of industrialization and residential expansion on traditional agricultural zones within the peri-urban district causing irreversible loss of fertile land (prime lands), threatening local food security and decreasing agricultural productivity.

In Zamboanga City, being a highly urbanized city, the rapid conversion is often driven by population growth and economic development, which outpaces land-use planning, creating a mix of high and low-density areas that are challenging to manage but necessitates conversion to meet development demands and economic opportunities for more than 1.0 million people.

3.2 Production of alternative caloric food crops barangay^{-1}

Table 2 shows the distribution of production areas for key alternative caloric food crops (ACFC) across the 10 peri-urban barangays. It indicates a total cultivated area of 403.7 has for the various ACFCs, such as corn and cassava serving as the primary drivers of agricultural land use in the district.

Table 2: Production area (ha) of alternative caloric food crops (ACFCs) barangay^{-1}

TYPE OF ACFC	Production Area Per Barangay (ha)[3/]										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Corn	22.5	40.0	10.0	30.0	32.0	35.0	38.5	-	50.0	12.5	**541.0**
Cassava	5.0	10.0	5.0	10.0	5.0	5.0	5.0	-	10.0	5.0	**120.0**
Banana	0.22	3.33	57.71	2.77	1.11	1.11	1.11	0.22	3.33	1.11	**144.0**
Sweet Potato	-	-	-	-	1.17	-	-	-	-	-	**2.3**
Total	**27.72**	**53.33**	**72.71**	**42.77**	**39.28**	**41.11**	**44.61**	**0.22**	**63.33**	**18.61**	**807.3**

1=Ayala, 2=Cawit, 3=La Paz, 4=Maasin, 5=Pamucutan.
6=Sinunuc, 7=Talisayan, 8=Recodo, 9=Sinubong, 10=Tulungatung.
ACFC = alternative caloric food crops.
[3/]Office of the City Agriculturist (Ayala District).

Corn is the most commonly cultivated food crop (cereal crop) in the district, with a total of 541.0 has contributed 67.0% of the total area planted with alternative food crops. Of the 10 selected barangays, Sinubong is considered an important site where corn (white and yellow combined) is planted, totaling 50.0 has. Barangays Cawit and Talisayan are in close proximity, each with 40.0

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

and 38.5 has, respectively. In contrast, barangay Recodo reports no active corn production, which is likely a result of the limited available agricultural land and the heavy industrialization in the barangay (Table 2).

Cassava cultivation is uniform across the district, with barangays Cawit, Maasin, and Sinubong being the most productive, each with 10.0 has planted. However, sweet potato production is significantly localized, with barangay Pamucutan being the primary contributor (1.17 has) but contributing only 0.3% of the total land area planted (Table 2) despite presence of land areas potential for production.

Barangay La Paz is the principal producer, with 57.71 has (17.8%) compared to corn (10.0 has) (Table 2), despite that banana production is distributed across all barangays. This concentration emphasizes the barangay's favorable environmental conditions and elevation, which are also suitable for permanent fruit crops integrated in various agroforestry systems, reducing areas for banana. This shift is a response to diversification of crops as a prime response to changing climatic conditions and addressing low income especially in the upland areas. In contrast, adjacent barangays Recodo and Ayala maintain minimal banana plantations, with each grove spanning only 0.22 ha along with barangays Pamucutan, Sinunuc, Talisayan and Sinubong with respective contribution of 1.11 has (Table 2).

The district's high-value agricultural production is primarily concentrated in areas with favorable microclimates and higher elevations, with barangay La Paz being the most famous example, the primary center for temperate "Cole" crops (and other high valued vegetable crops) that are otherwise challenging to cultivate in lowland tropical conditions, as a result of its unique geographic location, which is characterized by cooler temperatures and elevations that reach 1,500 masl. Barangay La Paz maintains the largest production area in the cultivation of assorted highland vegetables, accounted to more than 25.0 has. This specialized output is significantly greater than that of other producing areas, which is significantly larger than the 5.0 has managed in barangay Pamucutan. The comparative advantage of barangay La Paz in the maintenance of high-value agricultural commodities that necessitate specific climatic conditions is emphasized by these figures (Table 2).

3.3 Yield of alternative caloric food crops per barangay

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

Table 3: Yield ha^{-1} (mt) of alternative caloric food crops (ACFCs) barangay^{-1}

AFC	Estimated Yield Ha^{-1} (mt) Barangay^{-1}										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Corn	91.25	142.0	42.0	100.0	143.5	121.0	183.15	-	215.63	42.75	**1,081.28**
Cassava	80.0	160.0	80.0	160.0	80.0	80.0	80.0	-	160.0	80.0	**960.0**
Banana	1.79	26.61	641.2	22.17	8.7	8.7	8.7	1.8	26.61	8.7	**754.97**
Sweet Potato	-	-	-	-	35.0	-	-	-	-	-	**35.0**
Total	**173.0**	**328.6**	**763.2**	**282.2**	**267.2**	**209.7**	**271.9**	**1.8**	**402.2**	**131.5**	**2,831.3**

1=Ayala, 2=Cawit, 3=La Paz, 4=Maasin, 5=Pamucutan
6=Sinunuc, 7=Talisayan, 8=Recodo, 9=Sinubong, 10=Tulungatung.
[3]/Office of the City Agriculturist (Ayala District).

Table 3 presents the estimated yield per cropping season (mt). The data reveals a cumulative output of 2,831.3 mt for the primary caloric food crops, with significant variations based on crop type and geographic location. This suggests the district's reliance on maize (1,081.6 mt), cassava (962.6 mt), banana (756.0 mt) and sweet potato (31.1 mt), contributing 38.2, 34.0, 26.7 and 1.1%, respectively of the total production compared to sweet potato (35 mt) as primary caloric alternatives to rice. Barangays Pamucutan and Talisayan contributed 143.5 and 183.15 mt, respectively, while barangay Sinubong achieves the highest corn yield at 215.63 mt. Additionally, barangays Cawit and Sinunuc demonstrate exceptional performance, surpassing the 120.0 mt threshold compared to barangays La Paz and Tulungatung which exhibited the lowest maize yields (Table 3), which are likely the result of a shift in emphasis toward high-value temperate crops and permanent fruit trees such as durian, lanzones and mangosteen.

The production of bananas is notably centralized in barangay La Paz, which generates a substantial 641.2 mt. The barangay's status as a primary supplier for the district is substantiated by this high yield. Barangays Cawit and Sinubong are also substantial contributors, each contributing 26.61 mt (Table 3). The production of root crops continues to be a critical secondary caloric source, with cassava yields reaching their minimal as shown in barangays Cawit, Maasin, and Sinubong at 160.0 mt, respectively (Table 3). Barangay Pamucutan continues to be the sole producer of sweet potato, contributing 35.0 mt to the district's total caloric pool (Table 3).

The potential of ACFCs play a critical role in local and domestic food security by providing essential energy, diversifying diets, and offering resilience against changing climate and environments where rice cultivation is not a viable option. While rice is a major staple of most residents of Zamboanga City, relying on it exclusively makes food systems vulnerable to drought

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

and effect of El Nino, spread of pests and diseases, and climate instability, hence making the low land ecosystems vulnerable to lower yields and further result to food insecurity.

In addition to caloric staples, the district generates large amounts of vegetables grown as cash crops and local consumptions. Barangay Sinunuc is the leading producer of Petchay (10.84 mt) and Mustasa (16.42 mt), respectively. The high-value segment is dominated by barangay La Paz, with yields mostly on cabbage (205.47 mt) and lettuce (1.7 mt), respectively, demonstrating the most significant impact attributed to elevation and cooler climate. These observations underscore a definitive agricultural stratification: the lowland peri-urban regions prioritize hardy staples such as rice and lowland vegetables, whereas the highland environment of barangay La Paz is characterized by a focus on high-yield, high-value temperate commodities, where these commodities are highly sought and command a higher price. Market linkage is directed in the highly urbanized areas within the 7.0 km radius, where population is higher.

The high yield-to-area ratio of root crops and bananas in comparison to traditional cereals must be considered when predicting the future of caloric food crops in District I. The ***"Little Baguio"*** microclimate of barangay La Paz indicates that the district can be protected from fluctuations in rice supply by increasing the cultivation density of climate-resilient root crops (such as cassava and sweet potato) and high-calorie perennials (such as bananas and corn) in the peripheral peri-urban zones. It will be imperative to capitalize on the specialized production capacity of these 10 barangays, particularly the high-output zones of barangays La Paz, Sinubong, and Cawit, as Zamboanga City approaches 2030 and beyond, in order to achieve localized food sufficiency and the promotion of local food system approach (LFSA) for the Zamboanga City.

The observations further indicate that areas situated near rural areas (18-27 km) away from the city proper have larger land portions for agricultural production. These barangays are all under the Production Agricultural Sub-Zone (PDA-SZ) being administered by the Philippine Economic Zone Authority (PEZA), NPAAAD, and portions from IFP-SZ, such as barangays Lapaz, Sinubong, and Pamucutan, all part of the studied barangays. These barangays are distant from coastal areas (Foreshore Land Sub-Zone) and are highly considered as agricultural zones compared to the highly industrialized barangays of Sinunuc, Recodo and Ayala, where the industry are the main locations for most of the canning factories, fishing communities, and shipping services. Any food crisis could be perceived as a complicated link of socioeconomic and environmental factors. Broadly speaking, any phenomenon that threatens food security (FS) could constitute a driving force behind a food crisis especially to a highly urbanized Zamboanga City. In most cases, the alternative caloric food crops (ACFC) are described as crops that can be introduced into a new agroecosystem in lieu of "traditional" crops (rice) that are usually more susceptible to biotic and abiotic stresses. Highlighting the significance of ACFCs in peri-urban areas, as urban population

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

continue to increase, these ACFCs are considered relatively to be the hope in the uplands of peri-urban communities.

3.4 Economic Feasibility, Post-Harvest Processing, and Market Accessibility

Systemic integration of alternative food options across District 1 requires financial sustainability for farmers. While the physical volumes generated are promising (Table 3), cassava and sweet potato offer lower initial production costs and high yield-to-area distributions, presenting clear economic incentives for smallholders operating within limited spaces. However, distinct logistical bottlenecks limit market profitability. Cassava is subject to rapid post-harvest physiological deterioration (PPD), mandating processing or market distribution within 24 to 48 hours of extraction. The current supply chain depends on transport pathways running through corridors like Barangay Sinunuc to urban centers. This pipeline frequently encounters roadblocks due to a lack of cold-storage units and localized solar drying pads for corn grits. Without municipal investment to build decentralized storage and primary milling hubs in production centers like Sinubong and Cawit, physical production values will not reliably convert into farm revenue or affordable alternatives for city consumers.

3.5 Ecological Implications and Environmental Sustainability Controls

Scaling up alternative agricultural outputs across the district's remaining 3,148.31 hectares of available agricultural space introduces distinct ecological trade-offs. Highland production zones, specifically in the steep slopes of Barangay La Paz reaching 1,500 masl, are environmentally vulnerable. Intensive open-row cropping of corn or clear-cutting land for monoculture banana plantations on these inclines without proper soil conservation can worsen topsoil erosion, accelerate downstream sedimentation, and disrupt watershed channels. Furthermore, continuous intensive cropping carries the risk of depleting key macro-nutrients from the soil profile, which compromises long-term soil productivity. To achieve ecological balance, intensification strategies must use conservation agriculture techniques, such as contour plowing, intercropping with perennial agroforestry arrangements, and applying organic soil amendments. These activities should align closely with statutory land definitions under the Network of Protected Areas for Agriculture and Agro-Industrial Development (NPAAAD) to protect essential local ecosystem services.

The future of peri-urban and alternative food crops

The future of peri-urban agriculture in Zamboanga City and across Zamboanga Peninsula is transitioning toward high-tech, space efficient, and sustainable production models that addresses urban set ups that drives the need to bridge urban food gaps and improve food security for the 80% of the population that resides within the highly urbanized zones as defined by the new zoning

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

ordinance. Key trends include the integration of urban agriculture driven with smart farming technologies for growing root crops and high valued low land vegetables. But this needs technical and financial investments but will surely strengthening the rural-urban partnerships to provide fresh produce for the growing population in complementary. The potential of peri-urban barangays in District 1 to produce food crops as a substitute for the declining production sufficiency of rice in the city is timely and will address both food supplies and income.

Having a total land area of 7,162.0, of this total, 43.5% (3,115.5 has) is devoted as agricultural land area (ALA) to produce food. However, only 451.59 land area from ALA that were utilized for the current production leaving large portion unutilized and under-utilized. Production of corn, cassava, banana, and sweet potato as alternate to rice could supply carbohydrate-rich nutrient food crops of 2,831.3 mt (Table 3), and other important vegetables grown in these areas such as pechay (*Brassica rapa, L*), mustard (*Brassica juncea*), lettuce (*Lactuca sativa*), and cabbage (*Brassica oleracea*) with a combined yield of 362.15 mt per cropping season. This implies a very poor land resource utilization of 14% for food crops, and at average annual yield, the production may reach to 5,380.75 mt for carbohydrate-rich food crops and 1,433.22 mt vegetables crops, respectively.

Scenario-Based Optimization Projections for 2030 and Beyond:

To maximize the practical application of this dataset, future capacity can be projected across distinct development trajectories:

- **Scenario A (Status Quo / Continued Encroachment):** If land utilization remains flat at 14% while real-estate development continues to push outward into peri-urban spaces at an estimated loss of 1.5% of agricultural land annually, the district's food system will become increasingly vulnerable. By 2030, this pattern would cause the monthly milled rice deficit to grow beyond 9,011.0 mt, widening the local food gap.
- **Scenario B (Targeted ACFC Expansion):** At 100% resource utilization of available lands for agriculture, yield may reach up to 20,223.21 and 2,586.79 mt, respectively, contributing to the overall food production offering a more viable solution to food insecurity and availability of supplies to be distributed of markets [18][19]. If even half of this unutilized agricultural land (1,170.5 ha) is intentionally transitioned to structured alternative staples by 2030, the resulting seasonal increase of over 3,200 mt of caloric equivalents would offset roughly 35% of District 1's projected carbohydrate shortfall without requiring external trade purchases.

Hence, the production of sufficient alternative food crops addressing food insufficiency can be significantly done in the vast lands of the Peri-Urban areas. Providing an important avenue of agricultural production for the increasing population of the city [20][21]. These cultivated food crops identified in peri-urban areas suggest that future production and consumption may potentially

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

address the food insecurity issues that Zamboanga City and its residents faced. Alternative food crops can be grown in large areas and yield ha-1 exceeding that of rice. Cassava, sweet potato, banana and corn, offer several advantages over rice, primarily in the areas of nutritional density, environmental sustainability, health management, and climate resilience. While rice is a primary source of energy, these alternatives often provide more fibre and nutrients (vitamins and minerals), while requiring less water and fewer inputs, making the entire system climate smart, resilient and sustainable. Reducing food insecurity continues to be a major public policy challenge in Zamboanga City. Factors that constrain food supply and food demand invariably affect food security. Food security and insecurity are terms used to describe whether or not households have access to sufficient quality and quantity of food. Driving the potential of root crops, banana and corn as alternative sources of caloric energy and dietary nutrients. These crops are considered as the most important group of food crops after rice in Zamboanga City, the adaptation of these crops to marginal environments, their vital role in promoting food security in urban areas, upland environments and at the household level (urban farming) and their flexibility in mixed-farming systems offers a viable and sustainable alternative for the people of Zamboanga City, today, in 2030… and beyond.

4.0 CONCLUSION

The major alternative food crops that are grown as staple foods like cassava, sweet potato, banana and corn as alternate to rice are solutions to food insecurity faced by Zamboanga City. Recent findings point out that these alternative food crops together have the potential to contribute to food security. It is estimated that this contribution will have its impact to the continued increase of population until 2030 and beyond. This has become imperious in view of the emerging food crisis and climate variability with rising temperature, increasing drought and flooding occurrences annually, and continued change in environmental conditions, that surely will contribute further to food shortage and as urbanization prevails. It is in this scenario, the distinctive advantages and climate resilience of root crops, banana and corn (C4 crop) to such extreme and unpredictable variations are recognized.

These crops in particular are resistant to temperature stress (at some point) than rice crop (C3 crop), leafy and fruit vegetables, while at the same time having a great potential for contributing to food security. More than their recognition as high yielding-resilient crops, their production and utilization should be sustained and promoted through the creation of various Ordinances and action plan (way-forward plans) to support rural-urban development.

Ordinance on strengthening production and consumption of banana and root crops. This aims to promote the production and consumption of banana and root crops in Zamboanga City by providing enabling policies, technical assistance, resource access, and market support**.** These

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

resilient and nutrient-rich crops are well-suited to the city's diverse agro-ecological conditions. Supporting their cultivation not only improves farmer livelihoods and climate resiliency but also reduces dependence on imported rice. To further boost local consumption, the ordinance aims to encourage local Zamboangeños to integrate these alternative food crops into their daily diets, promoting better nutrition and cultural acceptance of locally produce alternative food crops.

Ordinance institutionalizing land suitability mapping for agricultural development. A second key legislative initiative will be the institutionalization of land suitability mapping, jointly to be conducted by the City Planning and Development Office (CPDO) and the Office of the City Agriculturist (OCA). This mapping is essential for identifying potential and strategic agricultural zones, including productive and unproductive areas. The resulting data will serve as a critical tool for evaluation and planning the expansion of alternative food crops production and guiding land use decisions that align with food security plan of the city.

Collaboration with DepEd to strengthen the "Gulayan sa Paaralan" program. To ensure long-term impact, the LGU – through the Office of the City Agriculturist (OCA) and its NUPAP (National Urban and Peri-urban Agriculture Program) – should collaborate with the Department of Education (DepEd) in enhancing the "Gulayan sa Paaralan" program. This initiative not only boosts local food production within schools but also instils in students the value of growing and consuming nutritious, locally available crops. Monitoring and capacity-building components should be integrated to sustain the program and increase awareness on the health and environmental benefits of alternative food crops.

ACKNOWLEDGMENTS

Special thanks to Prof. Elderico P. Tabal, Ph.D, College Dean; Asso. Prof. Elmer V. Galo, Ph.D; Asso. Prof. Ma. Jocelyn E. Quadra, MSA, and Ms. Queeneevi T. Quijano, MSA – Research Coordinator, and Asso. Prof. Norqueen T. Dumadaug, Ph.D., College of Agriculture, Graduate Program Coordinator, Western Mindanao State University.

REFERENCES

[1]. Tabal, E. P., Mendoza, T. C., Paelmo, R. F., Garcia, J. N. M., & Visco, R. G. (2021). Energy inputs of selected agroforestry systems in Zamboanga City, Philippines. *American Journal of Agriculture and Forestry, 9*(3), 106-113.

[2]. Tabal, E. P., & Mendoza, T. C. (2020). Accounting the net carbon sequestered of various agroforestry systems (AFSs) in Zamboanga City, Philippines.

[3]. Philippine Statistics Authority, 2002. Young Population Dominated in Zamboanga City.

[4]. Valerio, A. (2024). Balancing Urban Development and Environmental Sustainability: A Case Study of Zamboanga City, Philippines. *Cognizance Journal of Multidisciplinary*

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

Studies, 4(6), 10-47760.

[5]. Narvaez, T., Brillo, B., Cornerlio, N., & Rola, A. (2016). Industry level impact of the closed fishing season policy for sardines in Zamboanga Peninsula (Region IX) (No. 2016-12). Working Paper.

[6]. Costamero, J. L. (2023). Land conversion threatens Candaba Swamp, Central Luzon's 'flood sponge'. From Climate Tracker Asia: https://climatetracker.asia/land-conversion-threatens-candaba-swamp-central-luzons-flood-sponge/. Accessed April 17, 2026.

[7]. Amelework, A. B., Bairu, M. W., Maema, O., Venter, S. L., & Laing, M. (2021). Adoption and promotion of resilient crops for climate risk mitigation and import substitution: A case analysis of cassava for South African agriculture. *Frontiers in Sustainable Food Systems, 5*, 617783.

[8]. Gatto, M., Naziri, D., San Pedro, J., & Béné, C. (2021). Crop resistance and household resilience–the case of cassava and sweet potato during super-typhoon Ompong in the Philippines. *International Journal of Disaster Risk Reduction, 62*, 102392.

[9]. Paunlagui, M. M. 2016. Knowledge, Attitude, and Perception of Fishers and Sardine Factory Workers on The Closed Fishing Season Policy for Sardines in Zamboanga Peninsula (Region IX). Center for Strategic Planning and Policy Studies, College of Public Affairs and Development, University of the Philippines Los Baños, College, Laguna 4031 Philippines.

[10]. Hernandez, J. A., Tuaño, A. P. P., & Juanico, C. B. (2022). Development and characterization of the nutritional profile and microbial safety of rice-nixtamalized corn grits blends as potential alternative staple for household consumption. *Future Foods, 5*, 100127.

[11]. Department of Agriculture, 2018. Cabbage – Production Guide

[12]. Office of the City Agriculturist [OCA]. 2024. 2024 Annual Report. Agricultural Field Office II, Ayala District, Zamboanga City, Philippines. Unpublished.

[13]. Office of the City Agriculturist [OCA]. 2023. Zamboanga City Investment Plan 2023-2025. Zamboanga City, Philippines. Unpublished.

[14]. Office of the City Agriculturist [OCA]. 2024. Geotagging Data Report 2024. Zamboanga City, Philippines. Unpublished.

[15]. Pabuayon, I., Pantoja, B., & Manila, A. (2015). Addressing food security: saba banana and rootcrops as alternative food staples to rice in Quezon Province, Philippines. *Journal of Public Affairs and Development, 2*(2), 143-168.

[16]. Wang, P. Y., Fang, J. C., Gao, Z. H., Zhang, C., & Xie, S. Y. (2016). Higher intake of fruits, vegetables or their fiber reduces the risk of type 2 diabetes: A meta-analysis. *Journal of diabetes investigation, 7*(1), 56-69.

[17]. Ziska, L. H., Runion, G. B., Tomecek, M., Prior, S. A., Torbet, H. A., & Sicher, R. (2009).

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0

ISSN: 2455-6939

Volume: 12, Issue: 03 "May-June 2026"

An evaluation of cassava, sweet potato and field corn as potential carbohydrate sources for bioethanol production in Alabama and Maryland. *biomass and bioenergy, 33*(11), 1503-1508.

[18]. Song, B., Robinson, G. M., Bardsley, D. K., Xue, Y., & Wang, B. (2023). Multifunctional agriculture in a peri-urban fringe: Chinese farmers' responses to shifts in policy and changing socio-economic conditions. *Land Use Policy, 133*, 106869.

[19]. Gebre, T., & Gebremedhin, B. (2019). The mutual benefits of promoting rural-urban interdependence through linked ecosystem services. *Global ecology and conservation, 20*, e00707.

[20]. Ayambire, R. A., Amponsah, O., Peprah, C., & Takyi, S. A. (2019). A review of practices for sustaining urban and peri-urban agriculture: Implications for land use planning in rapidly urbanising Ghanaian cities. *Land Use Policy, 84*, 260-277.

[21]. Siyuan, S., Tong, L., & Liu, R. (2018). Corn phytochemicals and their health benefits. Food Science and Human Wellness, 7(3), 185-195.

 Copyright © 2026 by the authors. Licensed under CC BY-NC-SA 4.0