

## The Study of Food Security in the Special Region of Yogyakarta, Indonesia

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**Abstract.** Food security is a burden to realize sustainable development in achieving the zero hunger goal. This study aimed to examine the distribution of food security levels and the factors that influence food security in the Special Region of Yogyakarta. Quantitative analysis was carried out in this study based on secondary data. Determining food security was carried out by applying the Food Security and Vulnerability Atlas (FSVA) concept, which consists of three food pillars, namely food availability, access, and utilization. The results proved that Gunungkidul Regency was the area with the highest score for food availability, while the lowest was Bantul and Sleman. On the pillars of food access and food utilization, the highest was in Sleman, while the lowest was in Gunungkidul. The value of food security from the highest was the City of Yogyakarta (84.47), Sleman Regency (82.37), Bantul (79, 51), Gunungkidul (79.31), and Kulon Progo (79.03). All areas in DIY are included in very good food security. Food security policies need to handle food-poor households in villages through increasing nutrition knowledge. Meanwhile, it can be done in urban areas by expanding job opportunities and community empowerment.

**Keywords:** food security, FSVA, sustainable development, zero hunger goal.

### 1. Introduction

One of the goals of sustainable development is related to fulfilling food needs. Food security is important to support this goal, even though it is a burden for most countries in the world (Garbero & Jäckering, 2021). In 2019, more than 820 million people in the world were still hungry, with every one in nine sleeping in hungry (FAO et al. 2019). This condition causes a significant obstacle to achieving the zero hunger goal (Tora et al., 2021). Zero hunger which is the second top goal of sustainable development, is closely linked to other goals, such as responsible consumption and production (SDGs #12), reduced inequality (SDGs #10), and no poverty (SDGs #1)(United Nations, n.d.)(Yulianti & Ratnasari, 2020).

Developing countries are important case studies related to food because they suffer from food insecurity (Dhahri & Omri,

2020), including Indonesia. The consumption pattern of the Indonesian people only depends on rice, which is vulnerable. In terms of consumption, dependence on rice narrows food diversity. In terms of production, it is also vulnerable for three reasons: (i) rice growth depends on water irrigation, (ii) the uncontrolled rate of conversion of paddy fields, and (iii) limited land to widen paddy fields (Nasikh et al., 2021). The western part of Indonesia has a better food security index (IKP) than the eastern part (Yulianti & Ratnasari, 2020).

Food is a basic need and human right because adequate food in quantity and quality for everyone is an important factor for a healthy and productive life (FAO, 2014). The basis for realizing food security in Indonesia is regulated in Law (UU) no. 07 of 1996 Article 2 concerning Food that food development is carried out to meet

basic human needs that provide benefits fairly and equitably based on independence and not in contrast to community beliefs. The law was followed up with Government Regulation No. 28 of 2002 on food security which mandates that the government and the community are responsible for realizing food security.

Since the beginning of the twentieth century, the strategy to achieve food security has been dominant by intensifying food production to increase food availability (Raymond *et al.*, 2021). However, since 1996 at the World Food Summit, food security has expanded into four pillars: availability, access, utilization, and stability. Food availability shows the adequacy of food in quantity and quality for the community (Tora *et al.*, 2021). Access to food ensures that everyone has sufficient resources to supply the food they need. Food utilization includes food preparation, food distribution, water, sanitation, and health care practices. Stability is about ensuring the sustainability of the other three dimensions over time. Different processes can impact food security at different spatial levels (Graef *et al.*, 2014). The geographical differences of each region also affect food security (Rochmah & Ratnasari, 2019).

Monitoring food security is not enough to be seen from the relation between poverty and food security. Household characteristics such as education status and gender of the household head, and household composition are also significant causes of household food insecurity. Therefore, it is important to consider many variables for food security monitoring (Maitra & Rao, 2015).

Based on data from the Central Bureau of Statistics for the Special Region of Yogyakarta as of March 2020, the poverty rate in the Special Region of Yogyakarta (DIY) reached 475,072 people or 12.28 percent of the total population of DIY. This percentage is above the national average of 9.78 percent. This condition shows that DIY is still facing the threat of food insecurity. In addition, DIY is also faced with the problem of food production, namely crop failure. In 2019, according to the Department of Agriculture and Food Security (DPKP), there

were crop failures due to drought at a number of points, especially in Gunungkidul. The number of rice plants that fail to harvest will affect the level of food security, especially aspects of food availability. Another food security challenge is related to food access. According to O'Hara & Toussaint (2021), this aspect is very important for two reasons: first, food shortages can lead to nutritional deficiencies, and second, an excess of undernourished food can trigger health problems such as obesity, diabetes, and hypertension.

National food security does not always guarantee food security at the household level, but it is a prerequisite for the realization of food security at there. In addition, there are differences in food security between cities and villages. Based on Lantarsih *et al.* (2011), household resilience in the city is better than in the village. However, according to Graef *et al.* (2014), urban and rural food security are strongly interrelated and equally important. Rural food production may depend on consumers and markets in urban areas. On the other hand, urban food availability depends on rural production.

The first step to overcoming food insecurity is by identifying the level of food security. This is intended so that the distribution of the level of food security in the region, whether food insecure or food security can be identified. This research aimed to analyze the distribution of food security levels in DIY. In addition, this study found out the dominant factors that affect food security in DIY.

The role of GIS applications in analyzing food security is in processing food security parameters that are overlaid into a map of the level of food security. This research contributes to the monitoring and mapping food security and vulnerability in DIY. In the end, this research can assist local governments in developing or monitoring some to achieve the 2017-2022 DIY RPJMD mission.

## 2. Research Method

The study was conducted in the Province of the Special Region of Yogyakarta (Figure 1), located on the island of Java, Indonesia,

consisting of four districts and one city. Sleman Regency in the north, Kulon Progo Regency in the west, Bantul Regency in the south, Gunungkidul Regency in the east, and Yogyakarta City are located in the center of the province.

## 2.1 Data and Analysis

The research applied a quantitative analysis method using secondary data. The data consisted of food production (rice, corn, cassava, and sweet potatoes), paddy field area and area, mid-year population, number of underprivileged people, electricity and water sources per household, population with health complaints, level of education of women, number of health workers, number of underweight children under five, literacy rate, and life expectancy from the Central Statistics Agency and the Agriculture Service in Yogyakarta, as well as the main organization in the Indonesian food system, namely the Food Security Council, Indonesian Ministry of Agriculture.

## 2.2 Food Security Parameters

The concept for assessing food security in this research was the Food Security and Vulnerability Atlas (FSVA). Food security and a region's vulnerability are closely related to agriculture, demography, economy, infrastructure, social, and health. These factors are represented by three food pillars: food availability, access, and utilization. If one or more of the three pillars do not function properly, it will impact food security which in turn will cause food insecurity. The variables used for each pillar are presented in Table 1.

The food security parameters that have been processed were then carried out composite analysis by standardizing the value of each variable using the z-score. The index conversion results have a scale of 0 to 100. The conversion of calculated data into an index function so that all food security parameters have the same range of values. Calculation of the food security parameter index, namely (BKP, 2019):

$$Y = \Sigma a.X \quad (1)$$

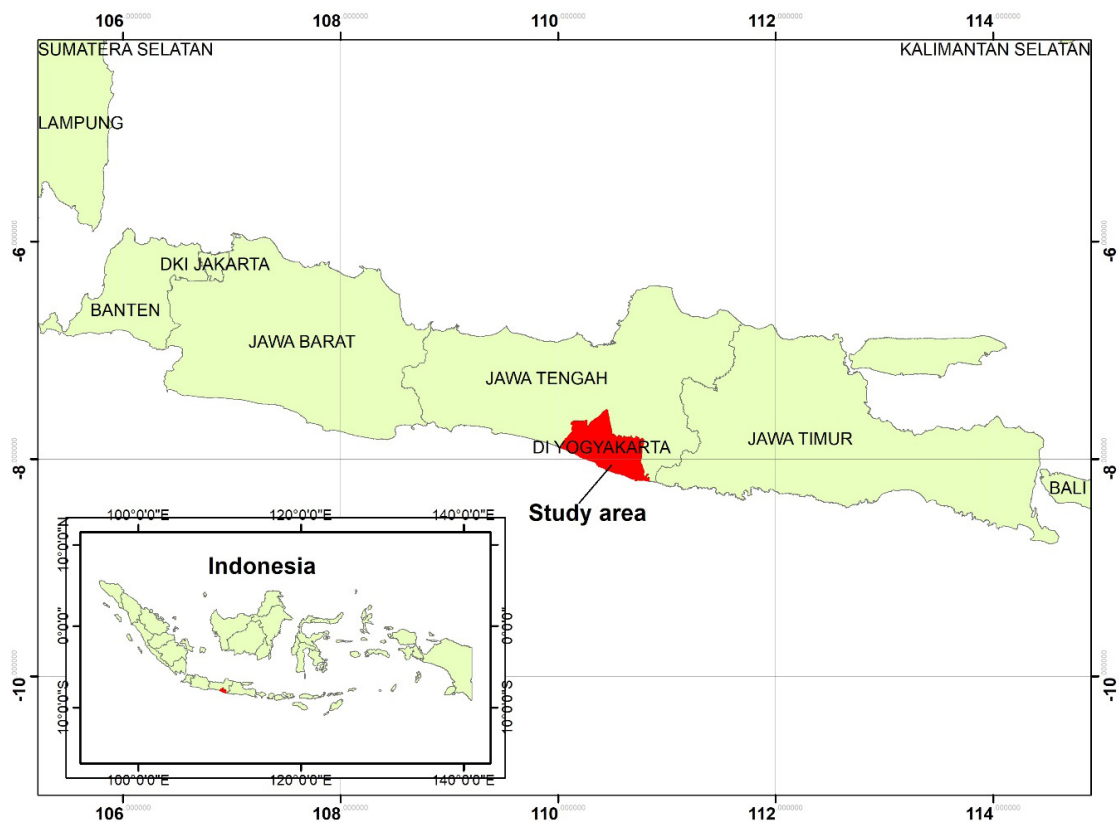


Figure 1. Research Location

Table 1. Research Variables

Variable	Information	Reference
$X_1$	The ratio of normative consumption of carbohydrates to net per capita production	DKP & WFP (2009)
$X_2$	The ratio of paddy field area to area	Nurhemi et al. (2014)
$X_3$	The ratio of the poor living population	Sardiana (2021), Widiyantoro et al. (2020)
$X_4$	The ratio of households without access to electricity	DKP & WFP (2009)
$X_5$	The ratio of the population without access to clean water	FAO (2014), Salmoral et al. (2018)
$X_6$	Pain rate ratio	BKP (2020)
$X_7$	The average length of school for women was over 15 years	BKP (2020); Fami et al. (2021)
$X_8$	The ratio of the illiterate population	Poudel & Gopinath (2021)
$X_9$	The ratio of population per health worker	BKP (2020)
$X_{10}$	The weight ratio of substandard toddler	von Grebmer et al. (2019)
$X_{11}$	Life expectancy	DKP & WFP (2015); Rochmah & Ratnasari (2019)

The multiplication between each indicator value converted with the indicator weight was then summed. The food security analysis in urban areas only involved food affordability and utilization, considering that food availability at the urban level was not influenced by production originating from the region itself but trade between regions. Therefore, the normative consumption ratio indicator was not used in the area composite calculation for urban areas.

### 2.3. Spatial Analysis

Applying an information system with a spatial approach will facilitate data input, data processing, and analysis, as well as reporting the results of food security studies (Sardiana, 2021). Spatial analysis is one of the facilities available in ArcGIS software, including joint tables and overlays. Joint Table was done by combining data in Microsoft Excel of food security level parameters processed with attribute data from the spatial table of the administrative area. Overlays were used for mapping the level of food security. Furthermore, spatial modeling was carried out by calculating the food security index (IKP) on the map resulting from the overlay. The results were in the form of a map

and food security index (IKP). The FSVA (Food Security and Vulnerability Atlas) IKP model was classified into six priority classes based on the severity and causes of the food security situation. Priority areas 1 and 2 were in most food-insecure, priority areas 3 and 4 were in moderately food-insecure, and priority areas 5 and 6 were in food security areas (DKP & WFP, 2015).

### 3. Results and Discussion

In Indonesia globally (Global Food Security Index), food security showed positive results during the 2015-2019 period, successfully rising in rank from 74 to 62 out of 113 countries. The improvement in the rating was due to an increase in the pillars of food availability and access by 3.1 and 5.2 points, respectively. The increase in Indonesia's food security was also reflected at the national level whereas many as 177 districts/cities have experienced an increase in food security status since 2015 (BKP, 2019). This research was conducted to measure aspects of food security in DIY using the FSVA method based on indicators from the pillars of food security. The value of each food security indicator in the research area is presented in Table 2.

**Table 2. The Value of Food Security Indicators in DIY in 2019**

Regency/City	X1 (%)	X2 (%)	X3 (%)	X4 (%)	X5 (%)	X6 (%)	X7 (year)	X8 (%)	X9 (%)	X10 (%)	X11
Kulon Progo	0,35	0,27	17,39	6,07	13,77	39,14	8,66	5,39	42,32	7,48	75,20
Bantul	0,67	0,42	12,92	7,49	23,13	36,94	9,54	4,78	19,65	4,90	73,77
Gunungkidul	0,12	0,35	16,61	8,82	9,02	35,76	7,13	4,30	53,63	6,16	74,03
Sleman	0,54	0,43	7,41	5,90	39,52	31,95	10,67	11,80	9,77	5,34	74,77
Kota Yogyakarta	-	-	6,84	3,84	49,90	39,59	11,45	1,05	0,80	5,72	74,56
Mean	0,42	0,37	12,23	6,42	27,07	36,68	9,49	5,46	25,23	5,92	74,47

Indonesia's FSVA food security model is divided into three pillars: food availability, access, and utilization (DKP & WFP, 2015). In the research area, based on Table 2, food availability which consists of  $X_1$  and  $X_2$  the average values are 0.42 and 0.37 percent, respectively. Food access which consists of  $X_3$  and  $X_4$  an average value is 12.23 and 6.42 percent. Food utilization consisting of  $X_5$ - $X_{11}$  average values are 27.07%, 36.68%, 9.49 years, 5.46%, 25.23%, 5.92%, and 74.47.

### 3.1 Food Availability

Applying an information system with a spatial approach will facilitate data input, data processing, and analysis, as well as reporting the results of food security studies (Sardiana, 2021). Spatial analysis is one of the facilities available in ArcGIS software, including joint tables and overlays. Joint Table was done by combining data in Microsoft Excel of food security level parameters processed with attribute data from the spatial table of the administrative area. Overlays were used for mapping the level of food security. Furthermore, spatial modeling was carried out by calculating the food security index (IKP) on the map resulting from the overlay. The results were in the form of a map and food security index (IKP). The FSVA (Food Security and Vulnerability Atlas) IKP model was classified into six priority classes based on the severity and causes of the food security situation. Priority areas 1 and 2 were in most food-insecure, priority areas 3 and 4 were in moderately food-insecure, and priority areas 5

and 6 were in food security areas (DKP & WFP, 2015).

**Table 3. Food Availability in DIY in 2019**

No	Regency/City	X1 (%)	X2 (%)	Food Availability
1	Kulon Progo	0,35	0,27	24,93
2	Bantul	0,67	0,42	23,93
3	Gunungkidul	0,12	0,35	27,06
4	Sleman	0,54	0,43	23,93
	DI Yogyakarta	0,42	0,37	24,96

### 3.2 Food Access

Availability of good food does not guarantee that an area is free from food insecurity (Susilo & Harini, 2018). There is another pillar to measure food security, namely the pillar of food access (affordability), which is a pillar that describes the ease of obtaining food. In this pillar, the variables measured are the percentage of the underprivileged population and the ratio of households without access to electricity. The results of the calculation of food access at the research site are presented in Table 4.

Areas with high population density face food security problems related to food availability, food insecurity, and the high number of pre-prosperous families thus, access to meet food needs is reduced (Sardiana, 2021). The poverty ratio ( $X_3$ ) in the districts of Kulon Progo, Gunungkidul, and Bantul is quite high at more than 10%. Based on Widiyanto's (2018) findings, most of the villages in Kulon Progo suffering from poverty and food scarcity are generally located in highland areas.

**Table 4. Food Access in DIY in 2019**

No	Regency/City	X3 (%)	X4 (%)	Food Access
1	Kulon Progo	17,39	6,07	22,08
2	Bantul	12,92	7,49	23,79
3	Gunungkidul	16,61	8,82	20,47
4	Sleman	7,41	5,90	26,18
5	Kota Yogyakarta	6,84	3,84	41,16
	DI Yogyakarta	12,23	6,42	26,74

Another indicator of food access is related to electricity. Households with access to electricity, mainly from State Electricity Company (PLN) sources, represent prosperity. The contribution of access to electricity (access to internet information) to food security shows additional avenues and capital accumulation to achieve food security (Poudel & Gopinath, 2021). Table 3 shows that all areas in the study area have a ratio of households without electricity (X4) entering the safe priority, which is less than 10%. Yogyakarta City and Sleman Regency have better access to electricity where the ratio of households without electricity is the lowest at 3.84% and 5.90%, respectively.

Agriculture is the main provider of food and income for the rural poor thus in improving food security, it is very important to support the agricultural sector. However, an increase in agricultural production does not necessarily lead to an immediate increase in food security (Garbero & Jäckering, 2021). Therefore, it is also necessary to ensure public access to food. The research area's highest food access or affordability index (Table 4) is Yogyakarta City, followed by Sleman Regency at 41.16 and 26.18, respectively. Gunungkidul Regency has the lowest access to food (20.47). Food security policies must provide guarantees for the poor to access sufficient food. Nevertheless, through their research, Graef *et al.* (2014) applied

the food value chains (FVC) approach and revealed that the rural poor were much more food secure because they were better prepared to deal with future environmental, social, and economic conditions changes that could affect food security.

### 3.3 Food Utilization

The availability of food must be utilized in such a way that although food production is seasonal, limited, and spread across regions, the volume of food available to the community must be sufficient in the quantity and quality aspects as well as its supply stable from time to time (Fandapofita, 2015). The results of the calculation of food utilization at the research site are presented in Table 5.

Based on Table 5, the percentage of households without clean water ( $X_5$ ) is below 30%, namely in Gunungkidul, Kulon Progo, and Bantul regencies so that they are in the very safe category, with respective values of 9.02%, 13.77%, and 23.13%, while Sleman Regency with a score of 39.52 is in the safe category. The city of Yogyakarta is the area with the most limited household to clean water (49.90%). This study's availability of clean water did not consider the Local Water Company (PDAM) water. This is because the use of water is associated with agricultural production. According to Salmoral *et al.* (2018), water utilization should be carried out with a systematic approach and integrated water management and population growth. However, in general, the distribution of water resources (water infrastructure) is more influenced by government decisions. Government policies such as the construction of dams and wells for irrigation, which do not consider the local community's views and the environmental impact, have increased the water crisis (Ladi *et al.* (2021).

**Table 5. Food Utilization in DIY in 2019**

No	Regency/City	X5 (%)	X6 (%)	X7	X8 (%)	X9 (%)	X10 (%)	X11	Food Utilization
1	Kulon Progo	13,77	39,14	8,66	5,39	42,32	7,48	75,20	32,01
2	Bantul	23,13	36,94	9,54	4,78	19,65	4,90	73,77	31,80
3	Gunungkidul	9,02	35,76	7,13	4,30	53,63	6,16	74,03	31,79

No	Regency/City	X5 (%)	X6 (%)	X7	X8 (%)	X9 (%)	X10 (%)	X11	Food Utilization
4	Sleman	39,52	31,95	10,67	11,80	9,77	5,34	74,77	32,26
5	Kota Yogyakarta	49,90	39,59	11,45	1,05	0,80	5,72	74,56	43,31
	DI Yogyakarta	27,07	36,68	9,49	5,46	25,23	5,92	74,47	34,23

Women's contribution to food security involves their contribution to production and the decisions they make regarding access to and use of food in the household (Asadullah & Kambhampati, 2021). Education for women positively affects food security by increasing job opportunities, entrepreneurship skills, income levels, purchasing power, and better decision-making, especially at home (Fami *et al.*, 2021). Table 5 shows areas with an average length of school for girls ( $X_7$ ) more than 9 years are very good, including Yogyakarta (11.45), Sleman (10.67), and Bantul (9.54). Kulon Progo with an average score of 8.66 years is in a good category, while Gunungkidul with a score of 7.13 years is in the medium category. Maitra & Rao (2015) reported their findings in Bangladesh that most food-secure households generally have more than eight years of education as their head of household.

The relationship between women and food is multidimensional, emerging as producers, consumers, homemakers, and social agents (Asadullah & Kambhampati, 2021). Women as implementers of household affairs in relation to development need to be empowered. Through empowerment, it is expected that women will be able to achieve self-sufficiency in the sense of fulfilling and meeting their basic needs so that household food security can be realized (Senjawati *et al.* 2020). However, based on the results of the literature review, Asadullah & Kambhampati (2021) that the transformation of agriculture by empowering women in agricultural work did not seem to function as a path to empowerment.

Furthermore, the educational aspect, such as food education through the recipe, sought to reduce health problems related

to food by changing eating habits through culturally appropriate eating patterns (O'Hara & Toussaint, 2021). Therefore, the literacy indicator ( $X_8$ ) is important to study. Based on Table 5, the highest illiteracy rate in the research area is in Sleman Regency and the lowest in Yogyakarta City, respectively 11.80% and 1.05%, while the other areas are in the range of 5%. This means that all regions in DIY have good literacy rates, only Sleman Regency is in the fairly good category. Poudel & Gopinath (2021) reported that an increase in the literacy rate reduced food insecurity by 1.07 percent, whereas a high illiteracy rate increased the likelihood of food insecurity; for example, in Ethiopia 77.1 percent of the illiterate sample households experienced food insecurity. Furthermore, Kehinde *et al.* (2021) also reported that illiteracy in Nigeria significantly reduces food security by 0.775 calories.

The population ratio per health worker ( $X_9$ ) indicates the ability of the number of health workers to serve the community. An adequate number of health workers will improve the status of community food utilization. Table 5 shows the ratio of the population to health workers in Gunungkidul and Kulon Progo Regencies of more than 30%, which means it is very inadequate, Bantul has a reasonably good status with a score of 19.65%, Sleman has adequate health workers with a score of 9.54%, while Yogyakarta is very adequate with a value of 0.54%.

Lack of food can lead to health problems (O'Hara & Toussaint, 2021). Based on the morbidity rate ( $X_6$ ), each region shows more than 30% which means that the health level in DIY is very vulnerable. Although susceptible to disease, the life expectancy ( $X_{11}$ ) shows more

than 70, meaning that the life expectancy of the DIY population is quite long. Likewise, the percentage of children under five with low weight ( $X_{10}$ ) in DIY is safe, below 20%. The areas where the most children with low weight are in Kulon Progo and Gunungkidul Regencies with a percentage of 7.48% and 6.16%, respectively, while the lowest was Bantul Regency with a score of 4.90%.

Based on the results of data analysis (Table 5), the value of food utilization from the highest is Yogyakarta City, Sleman Regency, Kulon Progo, Bantul, and Gunungkidul with respective values of 43.31, 32.26, 32.01, 31.80, and 31.79. The order is in line with the findings of BKP (2019) applying FSVA analysis in DIY, especially the aspects of food utility, although additional indicators were used in the study.

### 3.4 Distribution and Factors of Food Security

The food security condition in a region was obtained by overlaying a map of food availability, access, and utilization which produced a map of food security and a food security index. Based on the analysis, the food security index in the research area was obtained from the highest, namely Yogyakarta City (84.47), Sleman Regency (82.37), Bantul (79.51), Gunungkidul (79.31), and Kulon Progo (79.03).

The distribution of food security levels can be processed and presented spatially using a Geographic Information System (Figure 2). The figure shows that all regions in DIY in 2019 are in priority 6 which means they are very good food security, DIY is in a condition of fulfilling food, both food availability, community accessibility (affordability) to food and utilization. The results of the level of food security produced are in line with the (BKP, 2020) that all regions in DIY have very good food security. Although all regions are highly food insecure, there are different values for each pillar of food security. This can be seen in Figure 2.

According to each pillar, for the district area, Figure 3 shows that Gunungkidul District has the highest score for food availability, while the lowest is Bantul and Sleman. The highest food access pillar is in Sleman, while the lowest is in Gunungkidul, in the food utilization pillar the same thing occurs where the highest is in Sleman, while the lowest is also in Gunungkidul. Food availability in Gunungkidul Regency is highest because it is supported by the high production of cassava, corn, and rice and has the largest rice field in the DIY area. Sleman Regency has the highest access and use of food, supported by social, economic, and educational factors better than the other three districts.

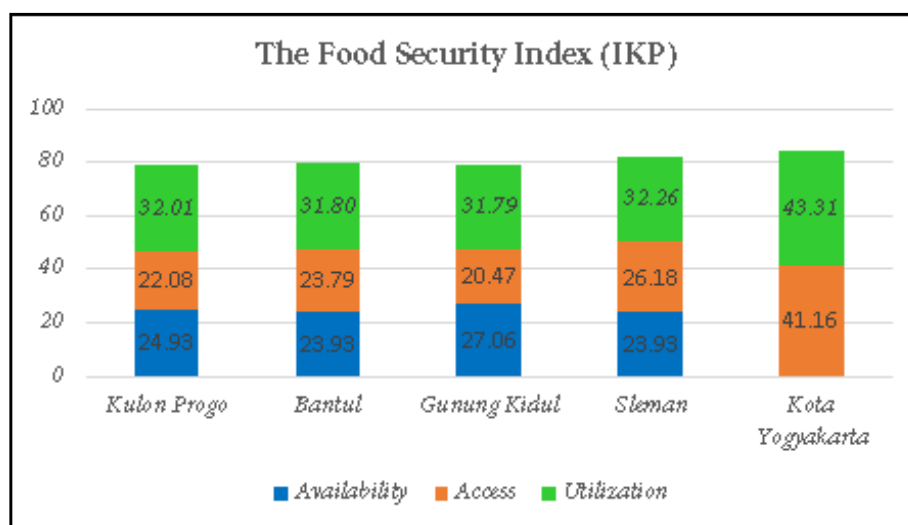


Figure 2. The Pillar Food Security Index in DIY in 2019



The main factor influencing food security in the research area is the pillar of food utilization (Figure 3). The same thing was found by Rochmah & Ratnasari (2019) in East Java that of the five variables that greatly determine food security, the top four variables are pillars of food utilization, namely the percentage of households without access to clean water, life expectancy, the ratio of health workers, and the percentage of children under five with below standard height.

As for the indicators (Table 2), Kulon Progo and Gunungkidul regencies are influenced by a very good food consumption ratio, Sleman Regency and Yogyakarta City are influenced by a low ratio of underprivileged population, while in Bantul Regency, it is influenced by the area of agricultural land. The findings in Sleman Regency and Yogyakarta City are in line with the findings by Teak (2020) 685 hectares or about 15.91% of the total area of Yogyakarta Province. The problem that arises from several areas in Bantul Regency is that there are still five villages that are indicated as food insecure. The government as the party in making decisions requires appropriate and accurate data and information in order to make policies regarding the problem of food insecurity. This study aims to determine the distribution of spatial data on the level of food security against food insecurity in Bantul Regency. The method used in this study is secondary data analysis which is characterized by the use of samples based on influential indicators adjusted to the FIA (Food Insecurity Atlas that the indicator that had the most influence on food insecurity is the indicator of the underprivileged population.

Food security policies need to be directed at handling poor households in the village by increasing nutrition knowledge to manage food consumption appropriately and efficiently to meet energy sufficiency. Meanwhile, food insecurity in households in the city can be done by expanding job opportunities and community empowerment (Lantarsih *et al.*, 2011). There is a

need for food production innovations in urban areas that can offer urban communities access to food while at the same time encouraging local food security. Food production can occur on roofs, in raised beds, hydroponic systems, parking lots, greenhouses, and abandoned factory buildings (O'Hara & Toussaint, 2021).

#### 4. Conclusion

This study examined food security in the Special Region of Yogyakarta using the Food Security and Vulnerability Atlas (FSVA) concept. A total of eleven indicators were studied, which are part of the three pillars of food security, namely food availability, access, and utilization. The results showed that all regions in DIY were categorized as having perfect food security. The pillar of food utilization contributes to food security in DIY. In this study, the use of food is analyzed from several parameters regarding clean water, health, and education. The research results provide scientific information to support policymaking and benchmarks for further studies to improve food security.

While we believe that the results are reasonable and accurate, better results can be obtained by including more indicators in the analysis. We hope that better data availability will make such detailed analysis possible in the future. The model in this study was still minimal due to limited data. Further in-depth studies are needed with more complete data and methods to complement the existing research results, and the results can be used as material for consideration by various parties related to efforts to achieve food security.

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