Extensive study of minimum agricultural land to support the food security

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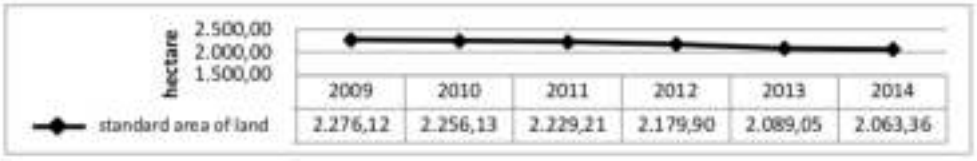
Abstract. The objectives of this study are (1) to determine the availability of food, income and food purchasing power of the residents of the City of Mataram and (2) To estimate the availability and area of minimum agricultural land for food in the City of Mataram. The research was conducted by survey method, and primary data collection was carried out by structured interviews using a list of questions, while secondary data collection was carried out by recording or copying from secondary sources at the relevant agencies. Data analysis was performed using functional equations with income constraints aided by SPSS software. The results showed that there was enough available food in the city of Mataram sourced from local production and sourced from food supply outside the city of Mataram, respectively. Amounted to 44% and 56% of the total rice food needs of 45,375 tons/year in 2013. Rice food expenditure is relatively small, which is between around 1.67% of the total income per capita of the population of Mataram City of Rp 5,880,000 / capita/year, so that in terms of access to rice food is relatively easy and inexpensive. The land for food continues to decrease due to land conversion from agriculture to non-agriculture use with a range of 4% per year. Without controlling the land conversion, it is projected that Mataram city is going to be rare in land for food within 25 years. To support regional food security in the city of Mataram city needs at least 453 to 569 hectares to produce the food sustainably, assuming a constant population.

1. Introduction

Land use conversion from agriculture to non-agriculture can easily be seen in many regions in Indonesia, including in Mataram city driven by the sharp increase of land for non-agricultural use. Over demand is unavoided as the increase of demand can be met by its supply. Opening rice land is unproportional to its' conversion. Potential agricultural development in the City of Mataran is still available, given the existence of agricultural land, especially irrigated rice fields. Some 240,761 hectares irrigated rice fields in West Nusa Tenggara Province, about 0.92% of paddy fields are in Mataram City. The area of paddy fields in Mataram City continues to decline from year to year, converted to non-agriculture use. In 2009, the area of 766.12 hectares paddy fields decreased to 2,063.36 ha in 2013, with an average decline of 1.94% / year.



2009	2010	2011	2012	2013	2014
2.276,12	2.256,13	2.229,21	2.179,90	2.089,05	2.063,36

Figure 1. Development of Raw Rice Area in 2009-2014.

Decrease in paddy land standard area, as described above, is quite alarming because it can result in a decrease in the potential of paddy field areas that can be used as agricultural cultivation areas and threaten regional food security in the city of Mataram. If this tendency is allowed to continue without control, then it is certain that the standard area of paddy fields will experience a reduction of around 4% / year. Thus it can be predicted that in the next 25 to 30 years, the entire agricultural land will switch to non-agricultural land.

The issue of land conversion from agriculture to non-agriculture has become a national issue and is urgent to find a solution, including the policy of determining the area of enduring productive land [1]. In Act Number 41 of 2009 concerning the Protection of Sustainable Food Agriculture in Article 9, the importance of planning and the realization of the provision and protection of sustainable agricultural land is carried out in the area of agriculture, agricultural land, and agricultural land reserves. The provision of sustainable agricultural land is based on population, food consumption needs, productivity growth, the need and availability of agricultural land, the development of science, and farmers' deliberations.

Criteria for agricultural land for food and land reserves are based on criteria for land suitability, infrastructure availability, land use, the technical potential of the land and/or the extent of the united land. The planning of the land area and distribution location of sustainable food agriculture land is the planning of the area of land reserves, existing land area, and the intensity of food crop agriculture at the national, provincial and district/city level. The city of Mataram as a regional entity is deemed obliged to fulfill the mandate of Law No. 41 of 2009 above by compiling the planning and realization of the provision and protection of sustainable agricultural land in agricultural areas, including seeking to maintain the preservation of minimum agricultural land area in the framework of regional food security. Apart from functioning as agricultural food producer to meet the food needs of the population, it also has ecological and environmental health functions in addition to aesthetic functions and other functions.

Given that the population of the City of Mataram continues to increase while the standard area of paddy fields continues to decline, the population between the number of residents and the area of paddy fields as land for food farming will widen, so that it can be ascertained that the ratio of paddy fields per person is getting smaller, i.e. from 0.61 are / person in 2009 to 0.50 are / person in 2013 (Table 1). This ratio will continue to be smaller in line with the increasing number of residents and the reduction in the area of paddy fields so that it can be ascertained that the availability of regional and household food will be smaller, so that food independence is increasingly difficult to achieve.

Table 1. Development of a wide gap in wetland with total population in 2009-2013.

Year	Number of Population (Persons) 1	Wide Area of Wetland (acre) 2	Gap of Wide Area of Wetland with Total population	Ratio Wetland Area / Person (acre / person)
2009	275,506	227,612	147,894	0.606147
2010	402,283	225,613	177,230	0.560052
2011	406,910	222,921	183,989	0.547839

2012	413,210	217,990	195,220	0.527553
2013	419,641	208,905	210,736	0.497818

Among the regional food, security components are the food approval recommended by the region in producing food to meet the food needs of its population. Regional development in producing food that is very focused with the development of vast agricultural land and increasing productivity of food crop farming. The development of food land area is largely determined by land conversion, while the increase in food is determined by the application of food crop cultivation technology [2]. Producing foodstuffs requires factors of production which contain factors of agricultural production, means of production, labor, and agribusiness management.

Food agriculture land is not only needed for the process of food production, but the demand for agricultural land also increases according to the demand for land prices to meet food needs, such as settlements, industry, and other infrastructure. The rate of increase in land prices for non-food needs must increase the additional costs incurred for agricultural activities so that economic costs for agricultural land are increasingly expensive. Farmers are increasingly tempted to give up land functions from agriculture to non-agriculture. This poses a complex and complex problem in accelerating the shift of agricultural land towards non-agriculture, which changes permanently and multiplicates. Empirically paddy fields are among the most vulnerable agricultural lands to land use change. Such conditions will continue, and it is agreed that there are no improvement efforts that can maintain regional resilience in the city of Mataram.

Such complex and complicated problems need to be sought for a trade-off that can protect various controversial interests. In an effort to produce trade-offs, a minimum agricultural land area study is needed to support regional food security in the city of Mataram.

Formulation of the problem. The results of a study conducted by Nazam, et al. (2011) concluded that the most influential factor on food security was the conversion of paddy fields from agriculture to non-agriculture [3], and a study conducted by Santosa et al. (2011) concluded that shifting the function of paddy fields is difficult to stop, so that efforts to maintain rice food security are increasingly difficult in the future and recommend the availability of eternal paddy fields through regulation of protection of paddy fields so that food security is maintained [4].

The conclusions presented in the two studies above correspond to the actual conditions in the city of Mataram that show the demand for land for non-agricultural purposes so rapidly, that the area of agricultural land (rice fields) continues to decline from year to year. The City Government of Mataram faces a difficult choice between carrying out the mandate of Law No. 41/2009 on the one hand and the pressure to change the function of agricultural land to non-agriculture on the other hand. The implementation of policies on conserving productive agricultural land has been challenged by developers and internal government for the construction of settlements, shops and infrastructure. The government also has an interest in maintaining the area of agricultural land (paddy fields) to ensure the achievement of regional food security.

As a problem in this study is "what is the minimum area of agricultural land (rice fields) that can support regional food security in the city of Mataram". This question must be answered because if not, the Mataram city food security program will be threatened with failure.

Research conducted by Nazam, et al. (2011) focus on determining optimum rice farming land area to support food independence [3], while Santosa, et al. (2011) examined the impact of land-use change on food security [4]. Ilsan, et al. (2013) examined the food security systems of poor households and food insecurity by comparing three types of agroecosystems (mountains, rice fields, and coastal areas) [5].

The minimum agricultural area study differs from the three studies above. This research is intended to obtain a minimum land area solution, with the main focus being regional food security with income constraints.

Food security is a popular research topic, including Nazam, et al. (2011) concluded that food

independence in West Nusa Tenggara was achieved if a minimum of 196,330 ha of paddy land area was out of 239,127 ha in 2010 [3]. Santosa, et al. (2011) concluded that the conversion of paddy fields continues and is difficult to stop; it is necessary to protect the enduring paddy fields [4].

Achieving food independence in the City of Mataram has certainly been difficult to achieve because the available agricultural land (paddy fields) (50 m2 per capita) is not possible to achieve, besides the remaining agricultural land area is not entirely owned by farmers. Therefore the concept of food self-sufficiency or food self-sufficiency is a choice of the past that is not relevant to current conditions. In an effort to meet the food needs of the population, the most likely choice is food security. Research conducted by Ilsan, et al. (2013) aims to formulate strategies for achieving food security that is specific to each type of mountain, paddy, and coastal ecosystem [5].

The general objective of this research is to assist the Regional Government in obtaining the right solution in addressing the transfer of function of agricultural land to non-agriculture by striving for the achievement of regional food security in the City of Mataram. From the general objectives of the study-specific objectives were formulated as follows: (1) Knowing the availability of food, income and purchasing power of residents of the City of Mataram; (2) Estimating the availability and area of minimum food agricultural land in the city of Mataram.

2. Methods

2.1. Research types and techniques

This research is a kind of descriptive research which is a study that describes the relationship between the area of agricultural land, especially rice fields and regional food security in a systematic, comprehensive, factual, and accurate way by using data and information relevant to the object of research.

Data collection is carried out by applying survey techniques, namely primary and secondary data collection carried out at the same time related to the object of research. Primary data was collected through face-to-face interviews with respondents using questionnaire aids. Primary data collected consisted of age, height, weight, food, and non-food consumption, agricultural and non-food land ownership area, household income from agricultural and non-agricultural sources, as well as consumption, speculation, and investment expenditure.

Secondary data was collected by copying techniques or recording from written sources that were published or not yet published or picked from sources stored in the Central Statistics Agency (BPS), related services/agencies including the Food Security Agency, Agricultural Service, Extension Agency at the provincial level in West Nusa Tenggara Province or the city of Mataram. Secondary data needed include population, number of households, household size, food and non-food expenditure, food and non-food consumption, normal food sufficiency, Broto regional domestic product, per capita income, food access, food distribution, area standard agricultural land (paddy), the productivity of farming food crops, food production, and food availability.

2.2. Research design

The selection of the village office and environment samples is done by selecting one village office in each subdistrict, which is done purposively (purposive) on the consideration that the selected village fice has food agriculture land especially the widest rice fields (Appendix 1). At the village office level, one neighborhood is chosen randomly.

Determination of frame sampling. In the selected environment, a list of names of household heads is quoted. Which is grouped into 2 (two), namely the head of the household with the main work as a food farmer and the head of the household with the main work not the farmer.

The selection of respondents was carried out in stages. The first stage was randomly selected as many as 10 farmers in each environment, and the rest was chosen after getting the number of sampling units in accordance with the rules of the methodology.

The number of respondents in each environment was calculated using the formula [6]:

$$ni = \frac{Ni.Zi^2\sigma i^2}{Ni.d^2+Zi^2\sigma i^2} \quad \text{..... (2.1)}$$

whereas:

ni = number of sample units in the i-th environment
Ni = number of population units in the i-th environment
d = maximum deviation that can be tolerated = 0.05
Zi = 95% confidence level = 1.96 according to the *z*-distribution table
σi^2 = population variance in agricultural land (rice fields) in the i-th environment.

As population variance σi^2 is unknown, approach was used b using a sample variance (S2) of the area of rice farming.

The sample variance is calculated using the formula:

$$Si^2 = \frac{(Xij-Xir)^2}{ni-1} \quad \text{..... (2.2)}$$

whereas:
Si2 = Variance of the i-th sample environment
Xij = area of agricultural land (paddy field) in the j th environment of the jth respondent
Xir = average area of agricultural land (paddy fields) in the i-th environment

As the unit of analysis are farm households and non-farm households in the city of Mataram. Farmer household is a household where the head of the household works as a food crop farmer. Food crop farmers are farmers who make rice farming at least one planting season per year. Non-farmer household is a household where the head of the household is not a farmer.

Data analysis. To achieve the objectives of the first and second research conducted by solving the problem of minimizing the agricultural land area of food with income constraints as follows. The objective function is to minimize food availability:

F = a1.X1 + a2.X2 ..... (2.3)
F = food availability
X1 = area of agricultural land for food (rice fields)
X2 = food imports (rice)
The constraint function is a certain income:
I = py ..... (2.4)
y = X1b1 ..... (2.5)
I = obedience
p = price
y = production
X1 = area of agricultural land for food (rice fields)
b1 = parameter
The Lagrange equation is as follows:
L = a1.X1 + a2.X2 + γ [I - p.X1b1] ..... (2.6)
L = minimizing food supplies
γ = Lagrange coefficient
The requirement to minimize food availability is the first derivative = 0
δ L / δX1 = a1 - γp.X1 b1-1 = 0 ..... (2.7)

X1 b1-1 = a1 / γp ..... (2.8)

To solve the above functional equation SPPS software is used.

3. Results and Discussion

3.1. Population food needs

3.1.1. Food Self-Sufficiency Approach. Every population needs food. Population food needs are the result of multiplying the population with food needs per capita. The following shows the food needs of the residents of the city of Mataram based on food needs standards. If each population needs 105kg / capita rice consumption, the need for rice consumption will increase in proportion to the increase in population. In 2013, the population was 432,144 people, so the need for rice was 45,375 tons/year, equivalent to 69,807.84 tons of harvested unhusked rice. In the same year, production of 30,873 tons of dry unhusked rice, equivalent to 20,067.45 tons of rice, was only able to be fulfilled from local production by 44%.

To meet the needs of the consumption of rice from the production of lowland paddy crop farming, a total of 4,723.77 ha of standard paddy fields is needed, while the available area of 2,089.05 ha in 2013. Thus, the standard size of available paddy fields in Mataram City is not will be able to meet the consumption needs of the population of rice, because the available area of raw rice fields is very limited and will continue to decrease as a result of the conversion of land use from agriculture to non-agriculture.

If the area of available agricultural land is increased its cropping index from 260% in 2013 to 300% in 2015, the available standard wetland area will not be able to meet the rice consumption needs of residents of the city of Mataram, so the choice is to import a portion of rice consumption needs by bringing rice from outside the city of Mataram.

Table 2. Development of population, estimation of rice needs, and conversion of milled dry grain in mataram city from 2008 to 2013.

	Total Population [1]	Rice Needs[2]	MPD Needs (ton)[3]
2008	362,243	38,036	58,516.18
2009	375,506	39,428	60,658.66
2010	402,843	42,299	65,074.64
2011	406,910	42,726	65,731.62
2012	413,210	43,387	66,749.31
2013	432,144	45,375	69,807.84

Source: 1) Mataram in Figures 2013 and the Central Statistics Agency of the City of Mataram
2) Estimation with the assumption that rice needs 105 kg/capita
3) Conversion of Rice to Milled Dry Grain (MPD) by 65%

Table 3. Size of raw rice fields, productivity, and production of paddy rice in the city of Mataram in 2009 - 2014.

Year	Raw rice area (Ha)	Productivity (ton/ha)	Crop Index	Production (ton)
2009	2,276.12	5.475	1.834	22,859.00
2010	2,256.13	5.552	1.968	22,521.00
2011	2,229.21	5.329	2.291	26,143.00
2012	2,179.90	5.343	2.346	27,328.00
2013	2,089.05	5.442	2.608	30,873.00
2014	2,063.36	5.466	2.778	*

Source: City of Mataram in 2013 and the Executive Board of the City of Mataram; *no data available yet.

From the comparison of consumption needs with rice production, there appears a wide gap, although rice production increased due to an increase in the rice cropping index and increased productivity of rice farming (Table 2), the need for rice consumption also increased (Table 3) so that the intensification of rice farming intensification is not able to meet the increasing needs of rice consumption.

3.1.2. Land-Rent Approach. One of a number of approaches to determine the minimum agricultural land area is land rent or compensation received by land owners because the land is used for productive economic activities. The value of land-rent is determined by various factors, including land fertility, availability and quality of irrigation networks, access to transportation infrastructure and housing, and land use. The most widely used measure to determine the value of land rent is land rent for one year. The amount of rent for agricultural land in the city of Mataram ranges between Rp 10 million - Rp 22 million per hectare per year. Table 4 shows that the greater the area of arable land shows the smaller the value of land-rent and conversely the narrower the area of arable land, the value of land rent increases. This is in accordance with the law of demand that the more scarce the agricultural land is, the greater the value of the land rent.

Table 4. The amount of rent of agricultural land in the city of Mataram in 2015.

Districts	Lease Area	Rental Value (Rp/Location)	Value of Land (Rp/ha)
Ampenan	1,13	15.000.000	13.300.000
Sekarbela	1,17	15.000.000	12.800.000
Mataram	0,75	7.500.000	10.750.000
Selaparang	0,80	17.500.000	21.875.000
Cakranegara	1,50	26.600.000	17.750.000
Sandubaya	1,00	10.000.000	10.000.000
City of Mataram	1,02	15.250.000	14.400.000

Source: Processed from primary data

Based on the primary data in Table 4 above, it appears that land rent is not merely determined by the area of the land, but more is determined by other factors. What appeared dominant was land fertility and access to irrigation and transportation infrastructure. The highest land rent is in the Selapang sub-district, Rembiga sub-district, and in the Cakranegara sub-district, Sayang-Sayang sub-

district, while the lowest is in the Sandubaya sub-district, Berta is sub-district and Mataram sub-district, East Pagutan sub-district.

While from the aspect of the agricultural land area shows that the lowest land rent is around 0.75 ha to 1.13 hectares. Judging from the aspect of fixed cost efficiency of farming, the land area is between 0.75 ha to 1.13 ha is an area with relatively small land rent.

By combining land rent data with the number of farm households, a minimum land area requirement in Mataram City can be calculated. The number of farmers in the city of Mataram in 2003 was 14,464 households, and in 2013 there were 5,719 households (BPS Kota Mataram, 2014). Using the latest data in 2013, the minimum area of agricultural land can be estimated to be around 4,289.25 ha to 6,464.47 hectares. The minimum land area is far above the standard paddy field area of 2,089.90 in the same year. By looking at the actual conditions on the ground, the land rent approach does not seem possible to be adopted, so a more realistic solution must be found.

3.2. Projected area of minimum agricultural land

Based on statistical data that the Gross Regional Domestic Product (GRDP) of the City of Mataram in 2012 amounted to Rp 2,429,710,747, while the population of the city of Mataram in the same year amounted to 413,210 people, then the per capita income would be Rp 5,880,000 / capita / year (City Mataram in Figures, 2013). Of the total income, around 1.67% is used to meet rice needs or equivalent to Rp 98,200 / capita per year (primary data). Through the food access approach, the residents of Mataram City have access to meet the food needs (especially) of rice, by importing rice from other districts in Indonesia. In reality, it is difficult to predict the availability of rice in the market because each rice-producing region strives to meet its own needs, so the amount of rice available in the market becomes an obstacle.

Through the regional food access approach, it is possible for residents of Mataram City to import rice from other districts such as Central Lombok, Sumbawa, and other districts within the West Nusa Tenggara region.

By using simultaneous equations obtained the following analysis results:

$$F = 10{,}9446\ X1^{**} + 0{,}1255\ X2 \quad \text{..... 3.1}$$
$$(p=0{,}000) \qquad (p=0{,}4162)$$

From the analysis, it is known that the coefficient of agricultural land area has a very significant effect (p = 0.0094) on the availability of household rice food in the city of Mataram, while the amount of food imports has no significant effect (p = 0.4162). Thus the addition of raw paddy fields is very influential on the availability of rice food. Each addition of 1 acre will increase the availability of rice food between 10-11 kg per month. The reality of the households surveyed shows that a portion of the yield of rice is stored as a food supply for rice, and the other part is sold to meet needs other than rice.

$$I = 6998{,}61^{*}y \quad \text{..... 3.2}$$
$$(p=0.000)$$

In equation 3.2, it appears that the production regression coefficient (y) has a very significant effect on income (p = 0.0000), meaning that each addition of 1 (one) kg of rice production will increase the household income of farmers by Rp6,998.61. Therefore the increase in productivity of rice farming has an impact on increasing the income of farmers (I).

$$\log y = 1{,}7637\ \log X1^{**} \quad \text{..... 3.3}$$
$$(p=0{,}000)$$
$$y = X1^{^{*1.7637}}$$

The structural relationship between production and land area is realized in the form of the Cobb-Douglass regression equation, as written in equation 3.3.

In equation 3.3 it is shown that the causality relationship between land area and production shows its significance at the real level of 0.99%, meaning that the area of raw paddy fields is significantly influential on increasing production, ie each addition of 1 (one) percent of farmland area results in an increase in rice production by 1.7637 percent. The increased increase gives an indication that the area of paddy fields is very determining production, without agricultural land, the opportunity to obtain production is almost non-existent even though using hydroponic technology or other technology, because the land is a space for farming which includes part of the surface of the earth where humans and resources others are processed to produce rice (paddy) production.

Furthermore, by using equations 3.1, 3.2 and 3.3 above, the minimum area of agricultural land is calculated as follow

$\gamma = (10{,}9446/6.998{,}61)^{*}1{,}7637 = 0{,}002758$

$L = 10{,}9446\ X1 + 0{,}1255\ X2 + \gamma\ [6.998{,}61\ X1^{*1{,}7637} - X1^{*1{,}7637}]$

$L = 10{,}9446\ X + 0{,}1255\ X2 + \gamma\ 6.997{,}61\ X1^{*1{,}7637}$

$\partial L/\partial X1 = 10{,}9446 + 0{,}002758 * 6.997{,}61 * 1{,}7637\ X1^{*0{,}7637} = 0$

$= 10{,}9446 + 34{,}0398\ X1^{*0{,}7637}$

$34{,}0398\ X1^{*0{,}7637} = (10{,}9446)$

$X1^{*0{,}7637} = 10{,}9446/(0{,}002758^{*}6998{,}61) = 0{,}5729$

X1 = 0,4822 are

If the data used are income and production per year, then the production function equation is as follows:

$Y' = 2.499{,}50 y^{**}$ 3.4

(p=0,0000)

$\log y' = 1{,}9929 \log X1$ 3.5

$y' = X1^{*1{,}9929}$

$\gamma = (10{,}9446/2.499{,}5)^{*}1{,}9929 = 0{,}00873$

$L = 10{,}9446\ X1 + 0{,}1255\ X2 + \gamma\ [2.449{,}5\ X1^{*1{,}9929} - X1^{*1{,}99297}]$

$L = 10{,}9446\ X + 0{,}1255\ X2 + \gamma\ 2.448{,}5\ X1^{*1{,}9929}$

$\partial L/\partial X1 = 10{,}9446 + 0{,}00837 * 2.448{,}5 * 1{,}9929\ X1^{*0{,}9929} = 0$

$= 10{,}9446 + 42{,}5812\ X1^{*0{,}9929}$

$42{,}5812\ X1^{*0{,}9929} = (10{,}9446)$

$X1^{*0{,}9929} = 10{,}9446/0{,}00873^{*}2.499{,}5 = 0{,}5016$

X1 = 0,5052 are

Under conditions of limited land area, the minimum area of rice farming is 0.4822 ha to 0.5052 ha per household. Data from the Central Statistics Agency of Mataram City shows that the number of farmer households in 2012 was 112,625 households, so the minimum agricultural land requirement is 543 ha to 569 ha.

4. Conclusion

- There is enough available rice in Mataram City, which is sourced from local production and sourced from food supply outside Mataram City, respectively. Amounted to 44% and 56% of the total rice food needs of 45,375 tons / year in 2013.
- Rice food expenditure is relatively small, which is between around 1.67% of the total income per capita of the population of Mataram City of Rp 5,880,000 / capita/year so that in terms of access to rice, food is relatively easy and inexpensive.
- The area of agricultural land for food continues to decline due to land conversion from agriculture to non-agriculture with a range of 4% per year, so it is projected that the area of agricultural land will increasingly narrow from year to year, and if not controlled, agricultural land is projected within a period of time The next 25 years will switch to non-agricultural functions.

- In an effort to support regional food security in the city of Mataram, a minimum of 453 to 569 hectares of agriculture are provided, assuming a constant population.

5. Recommendation

- Mataram City Government needs to establish a sustainable, productive food agriculture area of at least 600 ha;
- Control of land conversion from agriculture to non-agriculture is very urgent to be implemented by tightening the granting of building permits, especially in productive technical irrigated rice fields;
- Providing relief or exemption from the obligation to pay Land and Building Taxes, especially for owners or tenants of rice fields that are used as locations for rice food production;
- Avoiding the development of public access roads in productive agricultural paddy fields, except farm roads as farmers' access to transport agricultural inputs and outputs and irrigation network infections;
- An urban farming design is needed that can increase farmers' incomes equivalent to non-farmer incomes in Mataram.

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