The study of potential area for urban farming at Surabaya City

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Abstract. Surabaya City is one of the big cities at East Java with rapid area development. This rapid area development, as usual, is followed by the rising of its citizen’s growth, which creates a challenge in fulfilling the food necessity. This problem causes the food prices to escalate because of its limited amount, but on the other hand, the requests are kept on increasing. Now on, food security is an important issue for Surabaya City. Thus, efforts of increasing the food security level must be done, one of these efforts is urban farming. This study aims to locate the suitable areas for urban farming activities at Surabaya City. To gain that aim, an analysis method of Wight Overlay is used. From This Weight Overlay Analysis, the result retrieved is in the form of chosen areas’ map which can be used as the urban farming activities locations. The chosen areas are distributed over to some locations at four districts of Benowo, Lakarsantri, Pakal, and Sambikerep.

Keywords: Area’s Identification, Urban Farming, Weighted Overlay

1. Introduction

The food necessity becomes the basic needs for human’s life sustainability, health, also as a source of energy for doing activities. The food necessity itself develops according to the number of the population, lifestyle, social and religion, income level, and individual taste [1]. The food security, based on UU No. 18 tahun 2012 (Indonesian regulation, number 18, of the year 2012), is a condition of the food fulfillment for the country to every individual, which reflected on the availability of enough food in amount and quality, save, various, nutritious, thoroughly, and affordable also not against toward religion, belief, and culture of the people, for sustainable healthy, active, and productive life [2].

The problems which related to food security are not only happened in countrysides. The more people live in cities than countrysides leads to a food security issue which should be well maintained. The city of Surabaya is the biggest metropolitan city at East Java, which has rapid regional development. This rapid development raises the also rapid population growth, which affects the foodstuff prices. The consequence is the foodstuff prices become more expensive, because of the limited amount, when the request is kept on escalating. To this day, Surabaya still depends on the continuity of rice supply from nearby areas, such as Sidoarjo, Gresik, and Lamongan for fulfilling its food necessity.

Thus, as explained previously, the food supply’s right amount, good quality, and thoroughly distributed to all level of society with affordable price, is become a challenge to all the food stakeholders, such as government, business world from BUMN (country’s business entity) and private sector, also
other related parties. Thus, an effort must be done for leveling up the food security of Surabaya by creating food sources inside Surabaya City or taking from the outside sources, which one of these efforts is by working on urban farming. In order to maintain this urban farming development at Surabaya City, a corresponding study is needed.

2. Research method

2.1 Research approach and type
The approach which is used in this study is a normative approach. The normative approach in this study is an approach which is used to formulate a strategy based on existing data and information, also is accorded to farming related regulations and laws at Surabaya City. Meanwhile, the research type of this study is comparative research. This study is done in order to compare the similarity or difference of two or more facts and characteristics of a study’s object based on a particular framework.

2.2 Data collection method
The data collecting method in this study is done through primary and secondary surveys. The primary survey is done through interviews with related stakeholders of local government and other parties which are expertise in urban farming plan. The data collected by secondary survey is done through a study of related literature, also by collecting data from public service agency or related institutions, they are Development Planning Agency for Surabaya City, Central Bureau of Statistics, and Food and Agricultural Security Services of Surabaya City. The used data in this study are:
1. The width of the farming areas
2. The availability of primary food
3. The width of crop yield
4. The map of existing areas’ usage
5. The existing map of agricultural designation areas distribution
6. The map of agricultural designation areas plan
7. RTRW (Spatial Development Plan) of Surabaya City

Beside using above data from related agency or institution, this study also observing theories and literature in the form of previous studies which is retrieved from periodical published journals from domestic also international sources. To be outlined, the theories’ sources are divided into:
1. The general manual, especially from textbooks
2. The specific manual, in the form of reports which are specially derived from professional journals.

2.3 Data analysis method
The data analysis of this study is in the form of a quantitative method. This analysis aims to locate and analyze the priority areas for urban farming at Surabaya City, by using weight overlay analysis technique of ArcGIS 10.1 software, or other versions of it.

Weighted Overlay Analysis Technique is a spatial analysis technique which combines various type of maps in an overlapping way/overlay by the support of Geographic Information System (GIS) Software [4]. In this method, a raster data which has pixel as the smallest unit of measurement is used, in order to have every pixel scored and assessed thoroughly. The following is the framework of the study analysis:
3. Result and discussion

3.1 The analysis of the potential areas determination for urban farming by existing farming approach

The used approach in determining the areas for urban farming is existing farming approach of the year 2018. This approach is used in order to accommodate the necessity zone for farming areas which is not included in the spatial development plan or RTRW’s spatial pattern plan of Surabaya City for the year 2018. Besides, based on the interview of the Field Agriculture Instructor of the Food and Agricultural Security Services, there are farming areas which are not accommodated by the spatial development plan of Surabaya City. Thus, by using this approach of existing farming, the scenario resulted by this study can become a suggestion for future RTRW of Surabaya City.

The existing farming areas which will be used are those areas that have already maintained by the Field Agriculture Instructor of the Food and Agricultural Security Services of Surabaya City, which located at the districts of Benowo, Lakarsantri, Pakal, and Sambikerep. Also, some farming areas which located on the land owned by the Surabaya City’s government with a status of the former of village’s treasury land that the existing condition of the usage type of these farming areas is rice field, fishpond, and moor/field.

Table 1. The distribution of existing farming areas at Districts of Benowo, Lakarsantri, Pakal, and Sambikerep

| District     | Sub District       | Areas’ Usage Types (Ha) | Total  |
|--------------|--------------------|------------------------|--------|
|              |                    | Rice Field | Fishpond | Moor/Field |        |
| Benowo       | Kandangan          | 5.73        | 217.27    | 0.57      | 223.57  |
|              | Klakah Rejo        | 15.50       | 15.50     |           | 15.50   |
|              | Romokalisari       | 490.76      |           |           | 490.76  |
|              | Sememi             | 9.09        | 217.40    | 8.73      | 235.23  |
|              | Tambak Osowilangun | 648.47      |           |           | 648.47  |
|              | Total of Benowo District | 14,82 | 1589.40 | 9.30 | 1613.52 |
| Lakarsantri  | Bangkingan         | 116.26      | 108.02    |           | 224.29  |
|              | Jeruk              | 107.75      | 2.06      |           | 109.81  |
|              | Lakarsantri        | 76.60       | 6.83      |           | 83.43   |
Before doing the location determination analysis, an indicator and parameter are needed as the determinant variables [5]. To determine the variables in this study spatial approach are used, thus, only spatial variables that is used in this study. Below is the variables’ synthesis of the suitability of urban farming location at Surabaya.

**Table 2. The Parameter of Areas’ Suitability Variables for Urban Farming at Surabaya City**

| No. | Variables          | Parameter                                      | Attributes                  |
|-----|--------------------|------------------------------------------------|-----------------------------|
| 1.  | Topography         | Below the elevation of 100 MAMSL               | 0 : elevation >100 MAMSL; 1 : elevation <100 MAMSL |
| 2.  | Soil Type          | Alluvial soil type                             | 0 : beside alluvial soil type; 1 : alluvial soil type |
| 3.  | Disaster Proneness | Outside Disaster Prone Areas                  | 0 : on disaster zone; 1 : outside disaster zone |
| 4.  | Land Slope         | Below 8% land slope                            | 0 : >8% land slope; 1 : <8% land slope |
| 5.  | Irrigation/Drainage| Inside 1 kilometer of irrigation/drainage’s buffer zone | 0 : >1 kilometer range to the irrigation system; 1 : <1 kilometer range to the irrigation system |
| 6.  | Road Access        | Outside 100 meters road’s buffer zone          | 0 : < 100 meters range to road; 1 : > 100 meters range to road |

From these six variables, the suitable farming areas toward the Surabaya’s spatial pattern plan are evaluated with the result as follows:

1. **Topography**

   The chosen farming areas will be assessed by its topography. The farming areas which located on <100 MAMSL (Meters Above Mean Sea Level) are scored as suitable, however, those areas which located >100 MAMSL are scored as not suitable. This is the result of the areas suitability:

   **Table 3. The suitability toward topography**

| District | Sub Districts | Not Suitable | Suitable | Total (Ha) |
|----------|---------------|--------------|----------|------------|
| Benowo   | Kandangan     | 223.57       | 1229     |            |
|          | Klakah Rejo   | 15.5         | 22       |            |
### Table 4. The suitability toward soil type

| Districts | Sub Districts | Suitability (Ha) | Total (Ha) |
|-----------|---------------|------------------|------------|
|           |               | Not Suitable     | Suitable   |
| Benowo    | Kandangan     | 82.1             | 141.6      | 223.6 |
|           | Klakah Rejo   | 12.6             | 2.8        | 15.5  |
|           | Romokalisari  |                 | 490.7      | 490.7 |
|           | Sememi        | 284              | 206.7      | 253.3 |
|           | Tambak        |                 | 646.6      | 646.6 |
|           | Total of Benowo District | 123.1 | 1488.4 | 1611.7 |
| Lakarsantri | Bangkingan   | 168.9            | 55.4       | 224.2 |
|           | Jeruk         | 38.1             | 71.7       | 109.8 |
|           | Lakarsantri   | 81.9             | 1.4        | 83.4  |
|           | Lidah Kulon   | 2.5              | 90.1       | 92.6  |
|           | Lidah Wetan   |                 | 20.9       | 20.9  |
|           | Sumurwelut    | 51.4             | 1.1        | 52.5  |
|           | Total of Lakarsantri District | 342.9 | 240.6 | 583.4 |

Based on their elevations, all the farming areas are scored as suitable because all those areas are under 100 MAMSL.

2. **Soil Type**

The chosen farming areas will be assessed by its soil type. The areas with alluvial soil type are scored as suitable. On the other hand, all areas which have other soil type are scored as not suitable. The following table contains the result of the suitability of existing farming areas toward its soil type.
According to the soil types at those four districts, the majority of areas have alluvial soil type, thus scored as suitable. From a total of 4,207.4 Ha, 3,357.7 Ha areas have suitable soil type. For Benowo District, the suitable soil type areas are 1,488.5 Ha from 1,611.6 Ha. 240.6 Ha from 583.5 Ha areas at Lakarsantri District have suitable soil type. 1,027.8 Ha areas at Pakal District have suitable soil type from a total of 1,411.6 Ha. All 600.8 Ha areas of Sambikerep District have suitable soil type.

### 3. Disaster Proneness

The chosen farming areas will be assessed by its fire and flood disaster proneness. The areas which located at the save zone from fire and flood disaster-prone areas are scored as suitable. On the other hand, all areas which located at the fire and flood disaster-prone areas are scored as not suitable. The table below is the result of the suitability of existing farming areas toward its disaster proneness.

**Table 5. The suitability toward fire disaster proneness**

| Districts   | Sub Districts | Not Suitable | Suitable | Total (Ha) |
|-------------|---------------|--------------|----------|------------|
| Benowo      | Kandangan     | 223.6        | 223.6    |            |
|             | Klakah Rejo   | 15.5         | 15.5     |            |
|             | Romokalisari  | 490.7        | 490.7    |            |
|             | Sememi        | 235.3        | 235.3    |            |
|             | Tambak        |              |          |            |
|             | Osowilangun   | 646.6        | 646.6    |            |
| Total of Benowo District | | | | **1611.6** |
| Lakarsantri | Bangkingan    | 224.2        | 224.2    |            |
|             | Jeruk         | 109.8        | 109.8    |            |
|             | Lakarsantri   | 83.4         | 83.4     |            |
|             | Lidah Kulon   | 92.6         | 92.6     |            |
|             | Lidah Wetan   | 20.9         | 20.9     |            |
|             | Sumurwelut    | 52.5         | 52.5     |            |
| Total of Lakarsantri District | | | | **583.5** |
| Pakal       | Babat Jerawat | 150.1        | 150.1    |            |
|             | Benowo        | 122.3        | 122.3    |            |
|             | Pakal         | 511.4        | 511.4    |            |
|             | Sumberejo     | 312.2        | 312.2    |            |
|             | Tambakdono    | 315.4        | 315.4    |            |
| Total of Pakal District | | | | **1411.6** |
| Sambikerep  | Beringin      | 115          | 115      |            |
|             | Lontar        | 159.7        | 159.7    |            |
|             | Made          | 230.1        | 230.1    |            |
Tab 6. The suitability toward flood disaster proneness

| Districts | Sub Districts | Suitability (Ha) | Total (Ha) |
|-----------|---------------|------------------|------------|
|           |               | Not Suitable     | Suitable   |            |
| Benowo    | Kandangan     | 157.3            | 66.2       | 223.5      |
|           | Klakah Rejo   | 15.5             | 15.5       |            |
|           | Romokalisari  | 490.7            | 490.7      |            |
|           | Sememi        | 157.1            | 78.2       | 235.3      |
|           | Tambak        | Osowilangun      | 646.6      | 646.6      |
|           |               |                  |            |            |
|           |               | Total of Benowo District | 1451.7 | 159.9 | 1611.7 |
| Lakarsantri | Bangkingan   | 101.4            | 122.8      | 224.2      |
|           | Jeruk         | 37.1             | 72.8       | 109.8      |
|           | Lakarsantri   | 5.1              | 78.4       | 83.4       |
|           | Lidah Kulon   | 56.2             | 36.4       | 92.6       |
|           | Lidah Wetan   |                  | 20.9       | 20.9       |
|           | Sumurwelut    |                  | 49.4       | 52.5       |
|           |               | Total of Lakarsantri District | 202.8 | 380.7 | 583.4 |
| Pakal     | Babat Jerawat | 112.8            | 37.3       | 150.1      |
|           | Benowo        |                  | 122.3      | 122.3      |
|           | Pakal         | 219              | 292.3      | 511.4      |
|           | Sumberejo     | 3.6              | 308.6      | 312.2      |
|           | Tambakdono    | 292.3            | 23.1       | 315.4      |
|           |               | Total of Pakal District | 627.7 | 783.6 | 1411.4 |
| Sambikerep | Beringin      |                  | 115        | 115        |
|           | Lontar        | 159.7            |            | 159.7      |
|           | Made          | 230.1            |            | 230.1      |
|           | Sambikerep    | 96               |            | 96         |
|           |               | Total of Sambikerep District | 0 | 600.8 | 600.8 |
|           |               | Total            | 2282.3     | 1925.2     | 4207.5 |

And on the other hand, as seen from the flood disaster prone of those areas at four districts, from a total of 4,207.4 Ha, 1,925.2 Ha areas are outside of the flood disaster zone. For Benowo District, the suitable areas are 159.9 Ha from 1,611.6 Ha. 380.7 Ha from 583.5 Ha areas at Lakarsantri District are suitable areas. 783.8 Ha areas at Pakal District are suitable areas from a total of 1,411.6 Ha. All 600.8 Ha of Sambikerep District are suitable areas.

4. Land Slope

The chosen farming areas will be assessed based on its land slope. The areas which located at the <8% slope are scored as suitable. On the other hand, all areas which located at the >8% slope are scored as not suitable. The result of the suitability of existing farming areas toward its land slope is shown below.

Table 7. The suitability toward land slope

| Districts | Sub Districts | Suitability (Ha) | Total (Ha) |
|-----------|---------------|------------------|------------|
|           |               | Not Suitable     | Suitable   |            |
| Benowo    | Kandangan     | 9.1              | 214.47     | 223.57     |
According to slope at those areas at four district, from a total of 4,207.4 Ha, 2,625.21 Ha areas have a suitable land slope. For Benowo District, the suitable areas are 1,537.07 Ha from 1,611.6 Ha. The areas from all 583.5 Ha at Lakarsantri district are not suitable. 1,085.43 Ha areas at Pakal District are suitable areas from a total of 1,411.6 Ha. 2.71 Ha from 600.8 Ha areas of Sambikerep District are suitable areas.

5. Irrigation/Drainage

The chosen farming areas will be assessed by the availability of irrigation. The areas which located inside 1 kilometer radius from the irrigation system are scored as suitable. On the other hand, all areas which located outside 1 kilometer radius from the irrigation system are scored as not suitable. The result of the suitability of existing farming areas toward its land slope is in the next table:

| Districts       | Sub Districts | Suitability (Ha) | Total (Ha) |
|-----------------|---------------|------------------|------------|
|                 |               | Not Suitable     | Suitable   |            |
| Benowo          | Kandangan     | 50.2             | 173.3      | 223.6      |
|                 | Klakah Rejo   |                  | 15.5       |            |
|                 | Romokalisari  | 137.1            | 353.7      | 490.7      |
|                 | Sememi        | 10.4             | 224.8      | 235.3      |
|                 | Tambak        | 144              | 502.6      |            |
| Lakarsantri     | Bangkingan    | 8.1              | 216.2      | 224.2      |
|                 | Jeruk         |                  | 109.8      |            |
|                 | Lakarsantri   | 5.6              | 77.8       | 83.4       |
|                 | Lidah Kulon   |                  | 92.6       | 92.6       |

**Table 8.** The suitability toward irrigation/drainage
Based on the irrigation’s availability at those four districts, from a total of 4,207.4 Ha, 3,356.3 Ha areas have reachable irrigation system. For Benowo District, the suitable areas are 1,269.9 Ha from 1,611.6 Ha. The areas from all 583.5 Ha at Lakarsantri district, 569.7 Ha are suitable. 1,060.2 Ha areas at Pakal District are suitable areas from a total of 1,411.6 Ha. 456.5 Ha from 600.8 Ha areas of Sambikerep District are suitable areas.

6. Road Access

The chosen farming area will be assessed by the road access range. The areas which located outside radius of 100 meters from the road access are scored as suitable. On the other hand, all areas which located inside radius of 100 meter from the road access are scored as not suitable. The result of the suitability of existing farming areas toward its road access range is in the next table.

Table 9. The suitability toward the road access

| Districts | Sub Districts | Not Suitable | Suitable | Total (Ha) |
|-----------|---------------|--------------|----------|-----------|
| Benowo    | Kandangan     | 46.87        | 176.69   | 223.57    |
|           | Klakah Rejo   | 11.39        | 4.11     | 15.5      |
|           | Romokalisari  | 134.45       | 356.24   | 490.7     |
|           | Sememi        | 123.86       | 111.36   | 235.22    |
|           | Tambak        |              |          | 646.63    |
|           | Osowilangun   | 170.26       | 476.36   |           |
|           | Total of Benowo District | 486.83 | 1124.76 | 1611.62 |
| Lakarsantri | Bangkingan   | 52.11        | 172.17   | 224.29    |
|            | Jeruk         | 9.82         | 99.99    | 109.81    |
|            | Lakarsantri   | 42.77        | 40.65    | 83.42     |
|            | Lidah Kulon   | 61.11        | 31.49    | 92.6      |
|            | Lidah Wetan   | 19.39        | 1.5      | 20.89     |
|            | Sumurwelut    | 35.55        | 16.91    | 52.57     |
|            | Total of Lakarsantri District | 220.75 | 362.71 | 583.48 |
| Pakal      | Babat Jerawat | 52.42        | 97.75    | 150.17    |
|            | Benowo        | 66.13        | 56.24    | 122.38    |
|            | Pakal         | 175.64       | 335.76   | 511.41    |
|            | Sumbergo      | 114.63       | 197.58   | 312.21    |
|            | Tambakdono    | 12.74        | 302.73   | 315.47    |
|            | Total of Pakal District | 421.56 | 990.06 | 1411.64 |
| Sambikerep | Beringin       | 54.58        | 60.39    | 114.97    |
Based on the road access range at those four districts, from a total of 4,207.4 Ha, 2,750.5 Ha areas are outside of road range, which is suitable. For Benowo District, the suitable areas are 1,124.77 Ha from 1,611.6 Ha. The areas from all 583.5 Ha at Lakarsantri district, 362.72 Ha are suitable. 990.07 Ha at Pakal District are suitable areas from a total of 1,411.6 Ha. 272.95 Ha areas from 600.8 Ha of Sambikerep District are suitable areas.

### 3.2 The analysis of suitability of the urban farming areas toward the existing areas by the farming area determination factors

After working on the suitability analysis for each variable, the operation of addition is done in the form of “if meeting the variable’s criteria is scored 1 and 0 if not”. Thus, from seven variables, the areas with the end result of 7 are chosen. The scoring system used is:

**Table 10. The scoring system for areas’ determination for urban farming**

| Score | Explanations | Suitability Value |
|-------|--------------|------------------|
| 1     | Do not meet 6 variables | Not Suitable |
| 2     | Do not meet 5 variables | Not Suitable |
| 3     | Do not meet 4 variables | Not Suitable |
| 4     | Do not meet 3 variables | Not Suitable |
| 5     | Do not meet 2 variables | Less Suitable |
| 6     | Do not meet 1 variable | Suitable |
| 7     | Meet all variables | Suitable |

The Weight Overlay Analysis’s result (on Picture 2.) is containing some locations of suitable areas for urban farming at Surabaya. The following table is the result of the suitability analysis of potential areas for urban farming.

**Table 11. The analysis of suitability of potential areas for urban farming**

| Districts | Sub Districts | Not Suitable | Less Suitable | Suitable | Total |
|-----------|---------------|--------------|---------------|----------|-------|
| Benowo    | Kandangan     | 10           | 94.6          | 119      | 223.6 |
|           | Klakah Rejo   | 0            | 8.5           | 6.9      | 15.4  |
|           | Romokalisari  | 29.4         | 212.7         | 248.6    | 490.7 |
|           | Semeni        | 3.1          | 92.9          | 139.3    | 235.3 |
|           | Tambah Osowilangun | 28.5    | 257.2         | 360.9    | 646.6 |
|           | Total of Benowo District | 71 | 665.9       | 874.7    | 1611.6 |
| Lakarsantri| Bangkingan     | 28.4         | 138.3         | 57.6     | 224.3 |
|           | Jeruk         | 2.2          | 9.1           | 98.4     | 109.7 |
|           | Lakarsantri   | 4.5          | 43.7          | 35.2     | 83.4  |
|           | Lidah Kulon   | 2.3          | 30.8          | 59.5     | 92.6  |
|           | Lidah Wetan   | 0            | 0             | 20.9     | 20.9  |
|           | Sumurwelut    | 14.1         | 25.9          | 12.4     | 52.4  |
|           | Total of Lakarsantri District | 51.5 | 247.8       | 284      | 583.3 |
| Pakal     | Babat Jerawat | 0.8          | 79.4          | 70.1     | 150.3 |
|           | Benowo        | 12.3         | 68.6          | 41.6     | 122.5 |
|           | Pakal         | 38.3         | 191.2         | 282      | 511.5 |
|           | Sumberejo     | 0            | 81.2          | 231      | 312.2 |
### Table 1: Suitability Analysis of Potential Areas for Urban Farming

| Districts            | Sub Districts | Not Suitable | Less Suitable | Suitable | Total |
|----------------------|---------------|--------------|---------------|----------|-------|
| Tambakdono           |               | 0            | 29.9          | 285.6    | 315.5 |
| Total of Pakal District |              | 514          | 450.3         | 910.3    | 1412  |
| Sambikerep           | Beringin      | 0            | 12.9          | 102.1    | 115   |
| Sambikerep           | Lontar        | 0            | 17.8          | 141.9    | 159.7 |
| Sambikerep           | Made          | 0            | 40.3          | 189.8    | 230.1 |
| Sambikerep           |               | 0            | 16.5          | 79.5     | 96    |
| Total of Sambikerep District |       | 0            | 87.5          | 513.3    | 600.8 |
| Total                |               | 173.9        | 1451.5        | 2582.3   | 4207.7 |

Based on the suitability analysis of potential areas for urban farming at those four districts, from total 4,207.4 Ha, 61.4% of it are suitable, 34.5% are less suitable, and the not suitable areas are 4.1%.

**Figure 2.** The map of suitability of urban farming areas at Surabaya City
Below are the percentage of the suitability of each districts areas:

a. Benowo District
   - Suitable: 64.5%
   - Less Suitable: 41.3%
   - Not Suitable: 4.4%

b. Lakarsantri District
   - Suitable: 48.7%
   - Less Suitable: 42.5%
   - Not Suitable: 8.9%

c. Pakal District
   - Suitable: 54.3%
   - Less Suitable: 31.9%
   - Not Suitable: 3.6%

d. Sambikerep District
   - Suitable: 85.4%
   - Less Suitable: 14.6%
   - Not Suitable: 0%

4. Conclusion
According to the previous result and discussion, it can be concluded that in determining potential areas for urban farming activities, there are six variables which should be considered. They are topography, soil type, disaster proneness, land slope, irrigation/drainage, and road access. From the suitability analysis by using weighted overlay method, the areas which have suitability factor for urban farming at Surabaya City are those areas at four districts of Benowo, Lakarsantri, Pakal, and Sambikerep, with the width for each district’s areas are 874.7 Ha, 284 Ha, 910.3 Ha, and 513.3 Ha.

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