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Evi Ramadhani, Syarifah H. Merashky, Bagus Sartono, et al.

Analysis of Identification of Food Insecure Household Characteristics Based on Regional Status in Aceh Province

Evi Ramadhani[1, a)], Syarifah H Merashky[1, b)], Bagus Sartono[2, c)], Alfian F Hadi[3, d)], Winny D Safitri[4, e)], and Teuku Akhdansyah[1, f)]

[1]*Department of Statistics, Syiah Kuala University, Banda Aceh, 23111, Indonesia*
[2]*Department of Statistics, Bogor Agriculture University, Bogor, 16680, Indonesia*
[3]*Department Of Mathematics, Jember University, Jember, 68121, Indonesia*
[4]*Survey and Policy Analysis Research Group (SPARG), Syiah Kuala, Banda Aceh, 23111, Indonesia*

[a)] Corresponding author: evi.ramadhani@unsyiah.ac.id
[b)] hilalunamrs@gmail.com
[c)] bagusco@apps.ipb.ac.id
[d)] afhadi@unej.ac.id
[e)] winny.safitri08@gmail.com
[f)] Akhdansyah@gmail.com

Abstract. The status of regions in Indonesia is divided into two categories, namely rural areas and urban areas. According to the Badan Pusat Statistik (2010), Aceh is ranked as the 12th most food insecure province in Indonesia, the Aceh Province's food security index score only reached 66.22%. Based on data from the Aceh 2020 Susenas, there are a total of 21% cases of food insecurity that occur in rural areas, and 17% in urban areas. Analysis using the classification tree method is used to see the Importance Variable of food insecurity on the status of regions in Aceh province. The results of the analysis shows that there are several similarities in the characteristics of food insecurity that occur in villages and cities. Based on the parameter tuning values for rural areas, the maximum AUC value of 0.66 is obtained at the 500 misplit, and for the urban area the maximum AUC value is 0.71 at the 400 min split. The characteristics of food insecure households in urban areas consist of the type of fuel used used for cooking, floor area of the house (m2), proper sanitation, drinking water sources, and education of the head of the household. Characteristics of food insecurity in rural areas consist of fuel used for cooking, education of the head of the household, type of wall in the residence, type of floor, and ownership of land on which they build a house.first, second, and third level headings (first level heading

INTRODUCTION

Food insecurity is a major issue in the fulfillment of public welfare because it will greatly determine the economic, social, and political stability of a country [1]. Food insecurity in a household can occur when a household cannot fulfil its balanced food needs. Food is the main basic need for humans that is needed and must be fulfilled all the times. The right to having food is a human right, as stated in Article 27 of the 1945 Constitution. The issue of food insecurity is also stated in the number two of the purpose in Sustainable Development Goals, namely to end hunger, achieve food security, improve nutrition and promote agriculture.

FAO defines food security as a situation “when people, at all times, have physical and economic access to safe and nutritious food to meet their dietary needs and dietary preferences for an active and healthy life”. According to this definition, there are three important interrelated components of food safety: availability, access and utilization. Therefore, a household is said to be food insecure if within a certain period of time it has sufficient food (food that is usually served in a day) for its members for the entire period. Otherwise, the household is not food safe [2].

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Based on Indonesia's Food Security Index data for 2020, Aceh Province ranked as the 11th most food insecure province in Indonesia, Aceh Province's food security index score only reached 70.92% [3]. This is closely related to the poverty rate in Aceh province, which until 2021 will be the province with the highest poverty rate in Sumatra. In 2021, it is recorded that the poverty rate in Aceh Province is 15.43% [4]. Poverty is closely related to food security because poverty can cause limitations in access to food.

The Indonesia Central Statistics Agency has classified villages into two regional status, namely urban villages and rural villages. Although the problem of food insecurity is often thought to only occur in rural areas, in reality, there are also many incidents of food insecure households in urban village areas [5]. For this reason, it is necessary to conduct an assessment to see if there are any difference in the characteristics of food insecure households between urban villages and rural villages so that the government can take appropriate policies according to the needs of each regional status.

One of the classification methods that can be used to see the differences in these characteristics is the classification tree method. Classification tree is a method of machine learning that the output is easy to understand and analyze, and easy to draw the conclusions. Analysis using the classification tree method is used to see the Importance Variable of food insecurity based on the status of regions in Aceh province.

MATERIALS AND METHODS

Classification Tree

Classification and Regression Trees (CART) is one of the methods or algorithms of the decision tree technique (decision tree). Classification and regression trees is a classification method using historical data to build a decision tree. The CART methodology was developed by Breiman, Friedman, Olshen, Stone in 1984. CART is a nonparametric analysis used to present decisions in the form of a binary tree. The main purpose of CART is to obtain an accurate set of data as a characteristic of a classification.

CART will generate a classification tree if the response variable has a categorical scale and will produce a regression tree if the response variable is continuous data. The main purpose of CART is to obtain an accurate group of data as a characteristic of a classification. The CART classification method has several advantages. First, CART is a nonparametric method so that there is no assumption of distribution of predictor variables that needs to be met.

Second, CART not only provides classification, but also estimates the probability of classification error. Third, this method makes it easier to explore and make decisions on complex and multivariable data structures because the data structures can be seen visually. Fourth, the final classification results are simple and classify the new data efficiently. Fifth, the ease of interpreting the results.

The CART algorithm goes through three stages, namely the formation of a classification tree, pruning the classification tree and determining the optimum classification tree.

1. Formation of a classification tree. This stage begins with determining the variables and thresholds to be used as separators for each node. The stages of forming a classification tree consist of:
   a. Sorting data used is a sample of learning data. The subset resulting from the sorting process must be more homogeneous than the previous sorting. The heterogeneity function used is the Gini Index because it will always separate the class with the largest/most important class in the node first. The Gini Index function is shown in equation (1).

$$i(t) = \sum_{i,j=1} p(j|t)p(i|t), i \neq j \quad (1)$$

Where p(j|t) is the proportion of class j at node t and p(i|t) is the proportion of class i at node t. Sorting selected will form a set of classes called nodes. The node will do the sorting recursively until the terminal nodes are obtained. The next stage is to determine the goodness of split criteria to evaluate the splitter from the s filter at node t with the formula:

$$\Delta i(s,t) = i(t) - pLi(t_L) - pRi(t_R) \quad (2)$$

The separator which produces higher Δi(s,t) is the best separator because it is able to reduce higher heterogeneity.

b. Determination of Terminal Nodes
The expansion of the tree will stop when at the node there are observations amounting to less than or equal to 5 ($n \leq 5$) [5].
In addition, the process of tree formation will also stop when it has reached the limit of the number of levels that have been determined or the level of depth in the maximum tree.

c. Class Label Marking
The determination of the class label on the terminal node is based on the rule of the largest number, that is, if:

$$p(j_0|t) = max t_j \frac{N_j(t)}{N(t)} \quad (3)$$

with:
p(j|t) : the proportion of class j on the vertices
t Nj(t) : the number of observations of class j at the terminal node t
N(t) : the total number of observations at the terminal node t
The class label for the terminal node t is j0 which gives the value of the alleged misclassification at the smallest t node of r(t) = 1 - maxjp(j|t) [6].

In the classification tree, there are several hyperparameters that must be controlled, one of which is min split. Min split is an option to specify what the minimum node size is allowed for splitting [7]. With the min split=30 option, the nodes containing less than 30 observations will not continue the splitting process and the algorithm will stop. If we reduce the min split value, then we will get a more complex tree, because nodes with little content are still allowed to be split. Apart from min split, there are also several other options/hyperparameters, minbucket which is the minimum number of observations in any terminal node. If only one of minbucket or min split is specified, the code either sets min split to minbucket*3 or minbucket to min split/3, as appropriate, and maxdepth used for Set the maximum depth of any node of the final tree, with the root node counted as depth 0. Default = 30 [8].

Classification tree can also generate variable importance. Variable importance represents the statistical significance of each variable in the data with respect to its effect on the generated model. A variable may appear in the tree many times, either as a primary or a surrogate variable. An overall measure of variable importance is the sum of the goodness of split measures for each split for which it was the primary variable, plus goodness * (adjusted agreement) for all splits in which it was a surrogate. In the printout these are scaled to sum to 100 and the rounded values are shown, omitting any variable whose proportion is less than 1% [9].

DATA AND VARIABLE

Data used in this research is secondary data from the Aceh National Socio-Economic Survey (Susenas) 2020. Data was collected by Central Bureau of Statistics using survey method. It was obtained 12.971 households in this survey. Classification tree analysis in this research ran by using software R version 4.0.4. There are 17 variables used in this research which contain of 1 target variable that is household food insecurity status and 16 input variables which are the indicators of food insecurity. The explanation about the variables for this research is shown in the Table 1.

TABLE 1. *Variable explanation*

No	Variable	Variable Type	Definition	Reference
1.	Food Insecurity Status	Target variable	A scale that can describe the inability of households or individuals to access the food they need on a regular basis. It's measured using FIES (Food Insecurity Experience Scale) with 2 categories; YES and NO.	[10]

No	Variable	Variable Type	Definition	Reference
2.	Cooking Fuel		Type of cooking fuel used by the household	[11]
3.	Type of Floor		Type of floor of household	[12]
4.	Head of Household Education Level		The level of Education of Head of Households.	[13]
5.	Floor Area		Area of house, discretization with CHI-MERGE	[14]; [15]
6.	Number of Saver		The number of household member that have saving.	[13]
7.	Sanitation Eligibility		The eligibility of sanitation of the household	[16]
8.	Source of Drinking Water		The source of drinking water consumed by household member	[16]
9.	Internet access	Input Variable	Internet accessibility	[17]
10.	Type of Roof		Type of roof of household	[12]
11.	Land Asset		Land asset status	[18]
12.	Drinking Water Eligibility		Drinking Water Eligibility	[19]
13.	Illiteracy Number		Illiteracy number in the household	[20]
14.	Electricity		Electricity accessibility	[21]
15.	Vulnerability of Household's Head		Head of household is woman with the member of household 0-14 years old	[22]
16.	Non-outpatient with sick status		Non-outpatient with sick status	[23]; [14]

RESULTS AND DISCUSSIONS

Overview of the Food Insecurity in Aceh Province

Food insecurities are often associated with rural areas, but in fact food insecurities can also occur in urban village areas. From the results of the data exploration, information is obtained regarding the incidence of food insecurity in Aceh based on regional status.

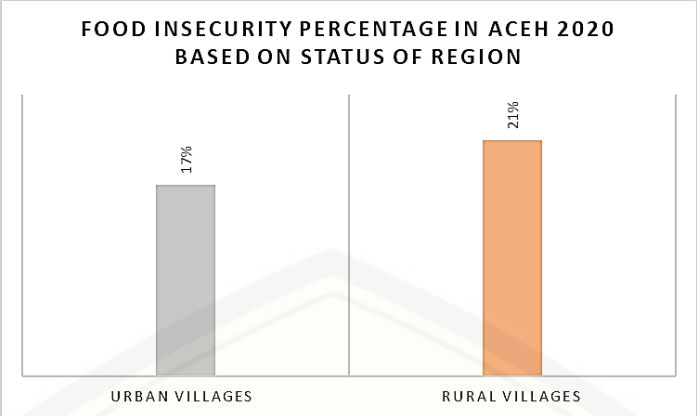

FIGURE 1. *Percentage of Food Insecurity*

Based on Figure 1, there are 21% of food insecurity that occur in rural villages and 17% of food insecurity occur in urban villages. There is no big gap between the two values, this indicates that the incidence of food insecurity occurs evenly in Aceh, both in urban and rural villages.

Tuning Parameter

To be able to obtain the variable importance, the first thing to do is to see the results of the parameter tuning, which in this study the tuned parameter is min split. In this study, the min split value used was 50, 100, 150, 200, 250, 300, 350, 400, 500, 600, 700, 800, 900, 1000. Meanwhile, the value of the cp parameter was 0. The AUC value was used to see the goodness of the model, where the higher the AUC value, then it means the model is getting better. So we will use the min split that generate the higher AUC.

TABLE 2. *Tuning Parameter (Min Split) of Classification Tree Food Insecurity in Aceh 2020 Based on Regional Status.*

Min split	AUC Urban Villages	AUC Rural Villages
50	0.6399890	0.6796612
100	0.6491873	0.6884000
200	0.6508225	0.7018758
250	0.6561404	0.7008079
300	0.6577543	0.6854008
350	0.6586238	0.6975446
400	0.6568508	**0.7101868**
500	**0.6605449**	0.6779614
600	0.6567054	0.6779614
700	0.6571876	0.6779614
800	0.6571876	0.6635703
900	0.6587124	0.6635703
1000	0.6587124	0.6635703

Table 2 shows the results of parameter tuning in the classification tree using Control Points (Cp) = 0 for food insecurity indicator data in Aceh Province for two different status of region, such as urban villages and rural villages with the optimum model value marked with yellow. The explanation the optimum model are obtained as follows:

1. For urban villages, the Area Under Curve (AUC) value is 0.66 at a min split of 500
2. For rural villages, the Area Under Curve (AUC) value is 0.71 at a min split of 400

Classification of Food-Insecure Households in Aceh Province

TABLE 3. *Variable Importance of Food Insecurity in Aceh 2020 Based on Status of Region*

Urban Area				Rural Area			
No	**Variable**	**VI Score**	**Rank**	**No**	**Variable**	**VI Score**	**Rank**
1	Cooking Fuel	398,3277572	1	1	Cooking Fuel	584,940711	1
2	Floor Area	158,3518254	2	2	Head of Household Education Level	209,035643	2
3	Sanitation Eligibility	141,9191811	3	3	Type of wall	177,805526	3
4	Source of Drinking Water	92,12048609	4	4	Type of Floor	110,851106	4
5	Head of Household Education Level	67,15412811	5	5	Land Asset	52,127565	5
6	Type of Roof	25,13665343	6	6	Floor Area	31,440412	6
7	Land Asset	18,12359797	7	7	Number of Saver	27,880259	7
8	Illiteracy Number	9,34928518	8	8	Type of Roof	10,104747	8
9	Type of Floor	9,05754121	9	9	Vulnerability of Household's Head	7,992365	9
10	Number of Saver	6,45890312	10	10	Internet access	6,007183	10
11	Electricity	1,37892944	11	11	Sanitation Eligibility	4,052022	11
12	Internet access	1,336826	12	12	Source of Drinking Water	3,055477	12
13	Non-outpatient with sick status	0,05620781	13	13	Drinking Water Eligibility	2,162586	13
14	Vulnerability of Household's Head	0	14	14	Electricity	0	14
15	Type of wall	0	14	15	Illiteracy Number	0	14
16	Drinking Water Eligibility	0	14	16	Non-outpatient with sick status	0	14

The results of the variable importance from the classification tree of food insecurity in Aceh based on status of regions provided by Rpart library from software R version 4.0.4 [24] shown in Table 3.

Based on Table 3, it is found that overall the importance variable of those two status of regions are different. The top five importance variables for indicators of food insecurity in urban areas in Aceh Province consist of the type of fuel used used for cooking, floor area of the house (m2), proper sanitation, drinking water sources, and education of the head of the household. Meanwhile, the top five importance variables for indicators of food insecurity rural areas in Aceh Province are consist of fuel used for cooking, education of the head of the household, type of wall in the residence, type of floor, and ownership of land on which they build a house.

CONCLUSION

The results of classification tree applied to identifying food insecurity indicators in Aceh Province can be concluded as follows:

1. The AUC value for the food insecurity indicator for urban villages in Aceh Province is 0.66 with an optimum min split of 500 and cp = 0, while the AUC value for the classification of food insecurity indicators for rural villages in Aceh Province is 0.71 with an optimum min split of 400 and cp = 0.
2. The top five importance variables for indicators of food insecurity in urban areas in Aceh Province consist of the type of fuel used used for cooking, floor area of the house (m2), proper sanitation, drinking water sources, and education of the head of the household. Meanwhile, the top five importance variables for indicators of food insecurity rural areas in Aceh Province are consist of fuel used for cooking, education of the head of the household, type of wall in the residence, type of floor, and ownership of land on which they build a house.
3. Variables that include in both status of regions are fuel use of cooking and education of the head of the household.

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