The dynamics of household food consumption patterns in various agroecosystems in Indonesia

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Abstract. Household food consumption patterns are influenced by income, price, individual tastes and beliefs, and socioeconomic aspects. Agricultural development has an impact on changing consumption patterns. The changes vary according to different ecosystems. The purpose of this study is to analyze the dynamics of household consumption patterns in various ecosystems and their implications for agricultural policies. This study used panel data from the National Farmers Panel period of 2007/2009-2016/2018 from the Indonesian Center for Agro Socio Economic and Policy Studies in four ecosystems, namely rice paddy fields, dry-land secondary crops, dry-land vegetable crops, and dry-land plantation crops. The discussion of consumption patterns is focused on energy and protein consumption, PPH score, and consumer participation rate. The results showed that during 2010-2018, energy and protein consumption increased, however, the pattern of change varies among households. The energy and protein consumption level are only about 77-86% from the level of recommendation ≥90%. Households’ consumption of protein in plantation ecosystem is lowest compared to other ecosystem. The level of household rice consumption was the highest, compared to other carbohydrate sources. PPH of agricultural households was lower than the national in the four agroecosystems. To increase the consumption of energy, protein and PPH scores of agricultural households in various agroecosystems in Indonesia, it is necessary to increase the availability and access of agricultural households to non-rice carbohydrate sources and protein source foods by optimizing the potential of local resources. Coordination and synchronization of food security improvement programs between central and local governments is important.

1. Introduction

Household food consumption patterns are influenced by many factors, such as the level of income, consumer tastes, the price of goods, education level, number of families, and the environment [1]. Sociocultural factors are strongly related to the types of staple food consumed and nutritional intake from diets [2]. In addition, the food consumption patterns of urban communities have changed towards ‘westernisation’ of the diet, with fast food and imported food products, including animal proteins, vegetables and fruits, dominating the diet, resulting in greater sensitivity to the international market. In the case of farming communities, food expenditure and consumption patterns can be influenced by land ownership, the type of farming practised, and other factors. Therefore, household food consumption pattern likely differs among agro-ecosystem.

One of the indicators used to measure household food security in terms of consumption is the level of daily energy intake per capita compared to the energy adequacy rate (AKE) in accordance with nutritional norms. According to Widyakarya Nasional Pangan dan Gizi X (WNPG), the recommended
adequate energy intake is 2,150 kcal/capita/day and adequate protein consumption is 57 g/capita/day [3]. Data on the average caloric intake of households in rice, plantation, secondary crop, and vegetable agro ecosystems show that they are food insecure; their caloric intake is < 2000 kcal/capita/day. Based on this background, this paper aims to analyse food consumption patterns of agricultural households and their implications as recommendations for food and agricultural policy. The analysis considers the dynamics of consumption patterns, including patterns of energy and protein intake, PPH scores, and national consumption participation rates, by agro ecosystem area. This information is important for policy makers to formulate food programs in each region based on agro ecosystem characteristics.

2. Materials and methods
The study used panel data from The National Farmers Household Panel Survey (PATANAS) conducted by Indonesian Centre for Agricultural Socio Economic and Policy Studies (ICASEPS) at the same location and with the same households at different points in time. The surveys were conducted with households in rice-based irrigated farming ecosystems in 2007, 2010 and 2016, in dry-land vegetable crops and secondary dry-land crops agroecosystems in 2008, 2011, 2017 and in dryland agroecosystems based on plantation commodities in 2009 and 2018. Data were collected using survey questionnaires based on the method of Food consumption data is a recall data for last seven days.

The study conducted in five provinces comprised of fourteen villages for 560 rural households with the number of respondents were 40 respondents per village. The data were then tabulated and grouped into nine food groups (grains, tubers, sugar, oily fruits/seeds, oils and fats, animal products, legumes, vegetables, and fruits). The food groups were then analysed using the approach of the nutritional adequacy rate (AKG) which was determined based on AKE using the formula,

\[ E_i = \frac{[B_i \times KE/100 \times (BDD/100)]}{JART} \]  

The protein adequacy rate (AKP) to determine the pattern of household food consumption based on quantity aspects was calculated with the formula,

\[ P_i = \frac{[B_i \times KP/100 \times (BDD/100)]}{JART} \]  

Furthermore, the desirable dietary pattern (PPH) score was calculated to determine food consumption patterns based on quality aspects. Household food consumption patterns are said to be ideal if they meet the criteria of an AKE of 2,000 kcal/capita/day, an AKP of 52 grams/capita/day and a PPH of 100. The energy adequacy levels were calculated using the following formula:

\[ TKE = \frac{\sum \text{energy intake}}{\text{Recommended AKE}} \times 100\% \]  

where:
TKE = Energy adequacy level
\( \sum \text{energy consumption} \) = Total energy intake
Recommended AKE = Recommended energy adequacy
JART = Number of Household Members

The PPH score was calculated using the total PPH score of the nine food groups. The PPH score of each food group was determined using the formula,

\[ \text{PPH} = \frac{(\text{energy consumption} \times 100\%) \times \text{Weighted}}{\text{AKE}} \]  

3. Results and discussion
3.1. Dynamics of energy and protein, the share of animal products and the PPH score
The energy and protein intake of agricultural households tended to increase but the pattern differed between households in each agroecosystem. This difference may be due to the nature of the agricultural commodities employed and to the variability in adaptation to fluctuations in output prices and climate change. Since 2015, the levels of energy and protein intake have met the recommended levels for a healthy and productive life. However, energy and protein intake in the four agroecosystems (rice, secondary crops, dry-land vegetable crops, and plantations) does not meet the recommended levels; the
rate of consumption only reached about 77-86% (Table 1), and the average energy intake was 1,702 kcal, lower than the recommended level [7]. In 2007-2018, the households in the crop agroecosystem had the highest level of energy intake at 1,992 kcal/capita/day, but in 2011, they had the lowest at 1,517/capita/day compared to households in the other agroecosystems.

Table 1. The dynamics of energy and protein consumption, the share of animal products and PPH score in each agroecosystem, 2007-2018.

| Agroecosystem | Energy (calori/kap) | Protein (gram/kap) | Share of animal products (%) | PPH score | Change pattern energy (%) | Change pattern protein (%) | Change pattern animal product (%) |
|---------------|---------------------|--------------------|-----------------------------|-----------|--------------------------|--------------------------|---------------------------------|
| Rice paddy fields |                     |                    |                             |           |                          |                          |                                 |
| 2007 (I)      | 1802                | 78.4               | 26.3                        | na        |                          |                          |                                 |
| 2010 (II)     | 1875                | 60.7               | 25.1                        | 69.2      | I to II                  | -4.05                    | -22.58                          |
| 2016 (III)    | 1726                | 56.8               | 25.1                        | 69.7      | II to III                | -7.95                    | -6.43                           |
| Plantations   |                     |                    |                             |           |                          |                          |                                 |
| 2009 (I)      | 1608                | 47.7               | 17.7                        | na        |                          |                          |                                 |
| 2012 (II)     | 1684                | 46.5               | 31.6                        | 68.5      | I to II                  | 4.73                     | -2.52                           |
| 2018 (III)    | 1530                | 47.7               | 41.4                        | 67.4      | II to III                | -9.14                    | 2.58                            |
| Dryland secondary crops |       |                    |                             |           |                          |                          |                                 |
| 2008 (I)      | 1992                | 51.8               | 21.9                        | 65.6      |                          |                          |                                 |
| 2011 (II)     | 1517                | 41.4               | 13.9                        | 62.3      | I to II                  | -23.85                   | -20.08                          |
| 2017 (III)    | 1625                | 51.3               | 21.7                        | 67.3      | II to III                | 7.12                     | 23.91                           |
| Vegetables    |                     |                    |                             |           |                          |                          |                                 |
| 2008 (I)      | 1570                | 45                 | 12.7                        | 64.3      |                          |                          |                                 |
| 2011 (II)     | 1799                | 58.2               | 24.1                        | 69.3      | I to II                  | 14.59                    | 29.33                           |
| 2017 (III)    | 1700                | 55.7               | 23.2                        | 74.8      | II to III                | -5.50                    | -4.30                           |

Description: na= no publishing data available

Based on the TKE value, household food insecurity was categorised into three levels: highly food insecure if TKE was ≤ 70%; food insecure if TKE was 71–89%; and food resistant if TKE was ≥ 90% [4]. The TKE values for the four agroecosystems suggested that household wellbeing and income from agriculture was lower than the national average. In addition, the PPH score was also lower than the national average (the maximum PPH was 100). The higher the PPH score, the more diverse the household food consumption, with a sufficient amount of food and a balanced diet [5]. During the three panel periods in rice paddy fields, the energy consumption level was still below the standard of nutrition adequacy rate. In contrast, the protein intake almost meets the minimum of adequate protein consumption level. In plantations agroecosystems, the average energy consumptions are 1607 kilocalories, smaller than recommended sufficient level. In secondary dryland crops, the average level of energy consumption increases but is still below the level of national standard sufficiency. Likewise, protein consumption is increasingly approaching the level of national sufficiency. In the vegetable agroecosystems, the aggregate average rate of energy was 1689 kcal, protein level of household energy consumption from 2011 to 2017 tend to decline. Its implications need to increase food consumption both in quantity and quality primarily to meet household energy needs.

The dietary energy intake of all households in this study did not meet the recommended level. However, the protein consumption of the households in the rice agroecosystem exceeded the recommended level. Among the four agroecosystems, plantation households had the lowest protein intake. This may be related to the low income of farmers in this agroecosystem; incomes may be low because of plantation trees/crops being too old so that production/crop yield is not maximised, especially if plants are not fertilised and sprayed against pests and diseases. This affects the income available for farmers to meet their nutritional needs [6].

3.1.2. Participation, level of consumption and household expenditure on food

It is important to analyse the level of household food consumption in an area because it can provide information on the extent to which a food commodity can be accessed by residents or households. Rice
has become the sole or main staple food of consumers, including farmers in all four agroecosystems who had the highest consumption rates compared to others (Table 2 and Table 3). All households in the study consumed rice as their staple food and have abandoned local food crops such as corn and tubers, whereas in eastern parts of Indonesia such as Papua and Maluku, formerly well known for sago, tubers and bananas are the staples [8]. In addition, significantly high quantities of instant noodles are currently consumed; this is in line with the ease of obtaining instant noodles in a variety of flavours and packaging and at different prices. Instant noodles have a role in food consumption patterns as a substitute for rice as well as a side dish. This has resulted in a drain on foreign exchange reserves, not only because raw materials for noodles (wheat) must be imported, but also because the diversity of food consumed, especially carbohydrate sources, is no longer based solely on local resources.

Fish, as an animal protein source, can be consumed fresh and processed as salted fish. Similar to rice, almost all households consume fish, indicated by a fairly high rate of consumption. Eggs have become a highly preferred source of animal protein derived from livestock, and are consumed by all households in all four agroecosystems. They can be obtained easily at a relatively affordable price compared to other animal protein sources; therefore, the price of protein per gram of egg is cheaper than the price per gram of chicken meat or beef [9]. The average world rice consumption is 53.9 kg/capita/year. Indonesia's total rice consumption is about 38.100 million tons, and the country ranks third in the world after China and India [10]. Flour consumption, including for production of instant noodles, has tended to increase. This pattern of consumption is evident not only in households aggregated nationally but also in rural households and the households in the four agroecosystems.

The increase in wheat consumption is not only due to the increase in instant noodle consumption but also to the increase in the demand for wheat flour for making various cakes, bread, fried foods and other finished foods [11]. Based on BPS data, Indonesia's wheat imports in January-June 2019 reached 36,467 tons, an increase from 31,905 tons in the same period in the previous year. Therefore, the government needs to re-energize the programme for diversifying food consumption based on local resources and culture. This effort will simultaneously increase farmers' incomes, enhance regional food security, improve public health and maintain ecosystem sustainability. The consumption of soybean, palm oil, granulated sugar, poultry meat, eggs, fish, and various vegetables and fruits tends to increase from year to year. Some of these types of food include strategically important food so that their availability in the market at an affordable price should remain a priority of the government.

Table 2. Consumption participation rate of some foods in each agroecosystems, 2007–2018.

| Types of food | Paddy 2007 | Paddy 2010 | Paddy 2016 | Paddy 2018 | Plantation 2007 | Plantation 2010 | Plantation 2016 | Plantation 2018 | Dry-land secondary crops 2007 | Dry-land secondary crops 2010 | Dry-land secondary crops 2016 | Dry-land secondary crops 2018 | Vegetables 2007 | Vegetables 2010 | Vegetables 2016 | Vegetables 2018 |
|---------------|------------|------------|------------|------------|----------------|----------------|----------------|----------------|----------------------------|----------------|----------------|----------------|--------------|--------------|--------------|--------------|
| Rice          | 100        | 100        | 100        | 100        | 100            | 100            | 100            | 100            | 100                        | 100            | 100            | 100            | 100          | 100          | 100          | 100          |
| Cassava       | 15,6       | 13,3       | 10,8       | 11,8       | 11,6           | 16,8           | 18,6           | 45,5           | 8,0                        | 12,0           | 52,1           | 4,0            | 6,0          | 4,0          | 6,0          | 4,0          |
| Noodles       | 83,3       | 69,2       | 62,5       | 81,6       | 81,5           | 80,0           | 91,3           | 76,0           | 67,6                       | 89,3           | 84,0           | 58,9           | 84,0         | 84,0         | 58,9         | 84,0         |
| Egg           | 81,6       | 81,6       | 88,3       | 74,3       | 74,4           | 81,6           | 94,2           | na             | na                        | 71,1           | na             | na             | na           | na           | na           | na           |
| Fish          | 93,4       | 92,8       | 90,8       | 89,8       | 89,8           | 96,1           | 97,1           | na             | na                        | na             | 95,0           | na             | na           | na           | na           | na           |
| Tempe         | 81,6       | 94,5       | 85,0       | 62,2       | 62,0           | 73,8           | 88,0           | na             | na                        | 88,4           | na             | na             | na           | na           | na           | na           |

Description: na= no publishing data available [7]

Table 3. Level of consumption of some foods in each agroecosystems, 2007 – 2018.

| Types of food | Paddy 2007 | Paddy 2010 | Paddy 2016 | Paddy 2018 | Plantation 2007 | Plantation 2010 | Plantation 2016 | Plantation 2018 | Dry-land crops 2008 | Dry-land crops 2011 | Dry-land crops 2014 | Dry-land crops 2017 | Vegetables 2007 | Vegetables 2010 | Vegetables 2016 | Vegetables 2018 |
|---------------|------------|------------|------------|------------|----------------|----------------|----------------|----------------|-------------------|----------------|----------------|----------------|--------------|--------------|--------------|--------------|
| Rice          | 103,9      | 126,8      | 115,7      | 108,3      | 97,2           | 93,0           | 91,8           | 93,3           | 106,2              | 105,6           | 100,9          |                |              |              |              |              |
| Cassava       | 2,0        | 19,5       | 24,3       | 2,9        | 3,6            | 3,0            | 3,5            | 3,2            | 2,6               | 3,7             | 0,9            | 1,5            |              |              |              |              |
| Noodles       | 3,7        | 1,2        | 1,2        | 6,0        | 5,1            | 6,1            | 3,1            | 3,8            | 3,5               | 2,6             | 2,8            | 4,3            |              |              |              |              |
| Egg           | 9,2        | 19,9       | 20,3       | 6,2        | 7,5            | 6,5            | 4,8            | 5,2            | na                | 8,6             | na             | na             |              |              |              |              |
| Fish          | 18,5       | 16,9       | 19,8       | 20,3       | 21,2           | 19,8           | 8,8            | 12,3           | na                | 12,8            | 13,5           | na             |              |              |              |              |
| Tempe         | 6,3        | 4,9        | 9,3        | 3,3        | 3,3            | 5,9            | 4,1            | 2,9            | na                | 3,7             | 3,5            | na             |              |              |              |              |

Description: na= no publishing data available [7]
3.1.3. Expenditure patterns and food consumption of rural households

The spending on food can be used as a proxy for household income, and food expenditure as a share of the total household expenditure can be used as a direct indicator of household wellbeing. Engel's law states that the higher the household income, the lower the allocation to expenditure on food, with no change in household preferences [12]. In this study, household expenditure on food at three points of observation (2007–2018) showed a nominal increase, which was observed in all agroecosystems (Table 4) at different levels of change. The increase at the beginning of the period was between 39% and 46%, while in the following period, it ranged from 25% to 66%, with the lowest increase found for dryland plantation households.

However, the increase on nominal terms does not reflect the actual conditions, meaning that the nominal increase is not necessarily an increase in real terms. Rice is the dominant staple food of households; therefore, the price of rice can be used as a deflator and the equivalent expenditure on rice can show the real value of expenditure.

Table 4. The dynamics of expenditure patterns and food consumption in PATANAS village, 2007-2018.

| Agroecosytems          | Expenditure (IDR/kap/month) | Change pattern (%) |
|------------------------|-----------------------------|--------------------|
|                        | I              | II              | III             | I-II | II-III |
| Paddy fields           | 276.212        | 399.435         | 663.199         | 44.6 | 66.0   |
| Dry-land secondary crops| 255.515        | 355.920         | 547.971         | 39.3 | 54.0   |
| Dry-land vegetable crops| 335.350        | 468.913         | 693.215         | 39.8 | 47.8   |
| Dry-land Plantation    | 379.445        | 555.118         | 691.464         | 46.3 | 24.6   |

Description: Paddy fields: Years I=2007 II=2010 III=2016, Dry-land secondary crops: Years I=2008 II=2011 III=2017, Dry-land vegetable crops: Years I=2008 II=2011 III=2017, Dry-land Plantation: Years I=2009 II=2012 III= 2018 [7]

In general, the value of real household expenditure during periods I to II increased in all agroecosystems, with the largest increase on average in the irrigated paddy agroecosystem, while it decreased in vegetable and plantation agroecosystems (Table 5). Although the average household income increased, some households experienced a decrease in real income, ranging from 34% (rice agroecosystem) to 43.7% (dryland crop agroecosystem) from the first to the second year. This phenomenon can be explained by the fact that in that period, the average price of plantation commodities, especially rubber and sugar cane as well as some vegetables (potatoes and cabbage), decreased nominally, with yields relatively fixed while prices decreased, causing a decrease in the income from farming [13]. In contrast, although the price of cocoa products increased, cocoa plantation production decreased in general, and cocoa farmers did not take advantage of the price increase. However, for most plantation households, the level of income increased (54%).

Table 5. The dynamics of real food expenditure in PATANAS village, 2007-2018.

| Agroecosystems          | Expenditure (IDR/kap/month) | Change pattern (%) |
|------------------------|-----------------------------|--------------------|
|                        | I              | II              | III             | I-II | II-III |
| Paddy fields           | 63.75          | 77.70           | 79.62           | 21.9 | 2.0    |
| Dry-land secondary crops| 53.53          | 55.96           | 64.95           | 4.5  | 16.1   |
| dry-land vegetable crops| 71.60          | 74.09           | 72.84           | 3.5  | -1.7   |
| Plantation             | 68.00          | 70.92           | 63.84           | 4.3  | -10.6  |

Description: Paddy fields: Years I=2007 II=2010 III=2016, Dry-land crops: Years I=2008 II=2011 III=2017, Vegetables: Years I=2008 II=2011 III=2017, Plantation: Years I=2009 II=2011 III=2018 [7]

Note: real food expenditure is nominal food expenditure divided with rice price

The spending on food as a share of the total household expenditure is an indicator that can be used to promote household wellbeing: the higher the proportion of expenditure on food, the lower the level of
household wellbeing. The PATANAS research [7] shows that the share of expenditure on food does not have a pattern that conforms to Engle's law. This inconsistency may be due to changes in household tastes, especially the switch to more high-quality and high-value foods. In the period I–II, household income (based on expenditure as a proxy) in all agroecosystems increased. However, this increase was mostly due to the expenditure on food; therefore, the spending on food as a share of household expenditure was still large. In accordance with Engle’s Law, a study of households in the vegetables field showed that a decrease in income (in 2011-2017) was followed by an increase in the share of food expenditure. Meanwhile, a decrease in household income did not change the share of household food expenditure in plantation agroecosystems; the share of this expenditure in 2012 and 2018 reached 60.3%. An increasing number of poor households prioritize adequate food needs and focus only on cheap and useful items to overcome hunger, resulting in lower food quality and a decrease in the household welfare level [14]. Households with a high welfare level are not only able to meet the needs for food, but non-foods as well [15]. Applying Engle’s Law, as income increases, the proportion of total expenditure allocated to food is reduced. In addition, as income rises, households can purchase quality food to meet their members’ nutritional needs.

4. Conclusions
Over the past two decades, the research of socioeconomic dynamics showed a downward change in food spending patterns, indicating an improvement in household wellbeing. However, the magnitude of the changes varies between types of agroecosystems. Increases in the amount, type and variety of household food consumption coincides with increasing income and changes in people’s appetites and lifestyles. Per capita calorie consumption tends to rise along with an increase in household income. However, the average per capita calorie consumption rate of households in all four types of agroecosystems is still less than the adequacy figure, and the main source of calories is still dominated by rice consumption.

The consumption level of corn-based food sources tends to remain unchanged, tubers generally increase and imported food, especially wheat, increases in line with the rise in per capita income and changes in people's tastes. Protein consumption per capita tends to increase alongside the rise in income and is still dominated by those from plant-based rather than animal food sources. The rise in fast food (i.e. instant foods) consumption, alongside increased revenue, advertising, promotion (i.e. food exposure) and lifestyle changes, impact the quality of nutrition consumed, food safety issues and aspects of halal food.

Efforts to increase the availability of and access to food are important in increasing calorie and protein consumption in households as well as PPH scores in the four types of agroecosystems. The strategy that needs to be taken is coordination and synchronisation of food security improvement programmes based on the potentiality of local resources.

To improve the understanding of important nutritional aspects in household food consumption and expenditure patterns, education and socialisation can prioritise the consumption of non-rice carbohydrate sources based on local resources, the dependence on imported foodstuffs should be reduced, and these products should be replaced by carbohydrate sources based on local food resources. The encouragement to increase local produce-based food consumption is also important through the campaign and promotion by Pangan Nusantara. Relevant agencies have an increasing role in promoting local food, the development of food-based culinary tourism, and sustainable use of home gardens for producing diverse and nutritionally balanced food sources.

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