Working Paper

Household food-security and nutritional status of women and children in Buol Regency, Central Sulawesi, Indonesia

Ratna Chrismiari Purwestri, Nia Novita Wirawan and Betha Lusiana

World Agroforestry Centre

Household food-security and nutritional status of women and children in Buol Regency, Central Sulawesi, Indonesia

Ratna Chrismiari Purwestri, Nia Novita Wirawan and Betha Lusiana

Working Paper 273

Correct citation

Purwestri RC, Wirawan NN and Lusiana B. 2017. *Household Food-Security and Nutritional Status of Women and Children in Buol Regency, Central Sulawesi, Indonesia.* Working paper 273. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI: http://dx.doi.org/10.5716/WP17365.PDF

Titles in the Working Paper series aim to disseminate interim results on agroforestry research and practices, and stimulate feedback from the scientific community. Other publication series from the World Agroforestry Centre include: Technical Manuals, Occasional Papers and the Trees for Change Series.

Published by the World Agroforestry Centre
Southeast Asia Regional Program
JL. CIFOR, Situ Gede, Sindang Barang, Bogor 16680
PO Box 161, Bogor 16001, Indonesia

Tel: +62 251 8625415
Fax: +62 251 8625416
Email: icraf-indonesia@cgiar.org
ICRAF Southeast Asia website: http://www.worldagroforestry.org/region/southeast-asia/

Working Paper no. 273

Photos/illustrations: the authors

About the authors

Ratna Chrismiari Purwestri is a nutrition specialist with special interest in women and children related to food and nutrition security especially among less privileged communities in Indonesia and Africa. She obtained her PhD degree at the Department of Gender and Nutrition, Institute of Social Sciences in Agriculture, University of Hohenheim, Germany. Her PhD thesis entitles: Supplementary feeding and cost analysis of locally produced Ready-to-Use Food (RUF) for moderately and mildly wasted children in Nias Island, Indonesia: daily and weekly programs. Currently, she works as a PostDoc researcher at the Institute of Biological Chemistry and Nutrition, Hohenheim University, Germany.

Nia N. Wirawan is currently an academic staff at the Nutrition Department, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia. She obtained her MSc on Community Nutrition at the Faculty of Medicine, Universitas Indonesia which jointly organized by SEAMEO-TROPMED RCCN-Universitas Indonesia. She teaches community nutrition monitoring at Brawijaya University. She also actively carries out research project on nutrition across Indonesia. Since 2017, she is a PhD student at the Faculty of Medicine, at the Universitas Indonesia.

Betha Lusiana is a scientist with the World Agroforestry Centre (ICRAF) Indonesia programme, where she leads the Ecological Modelling Unit. She has a PhD from Hohenheim University, Germany on Natural Resource Management. Her current research focuses on assessing the trade-offs between agricultural development, farmers' livelihoods, and ecosystem services using participatory, quantitative and/or model simulation approaches. In Buol, she coordinated an action research in developing PES-scheme in collaboration with the district government.

Abstract

Smallholder farmers contributes significantly to world's food and, yet they are the most food insecure. In Indonesia, 20 million people are malnourished, while food production in rural areas largely depends on smallholder farming systems. Trees can contribute significantly to the food security. It is of interest how trees contribute to the food security of smallholder farmers. This study aims to assess household food security of smallholder farmers and nutritional status of the women and children living in Buol, Central Sulawesi. A cross sectional survey was carried in December 2015 to January 2016 in three sub-districts, Buol, Central Sulawesi. Data on general characteristics, agriculture situation, and socio-demographic were collected using a structured questionnaire. Dietary intake data of women and children were assessed using a-24-hour food intake recall. Anthropometry (weight and height) of the women and children, as well as haemoglobin level of selected women were also measured.In total 200 pairs of women and their oldest under-five children. Based on type of farming system and occupation, respondents were categorized into four groups, as follows annual- (n=69), tree-based- (n=34), mix-crop- (n=55) and non-farmers (n=42). More than 60% of tree-based farmers said that they had a side job during the last one year, perhaps due to the less- time allocated for the typical tree-based crop farming activities in the study area as compared to annual cropping activities, in addition to the need in purchasing family food. Less than 50% of the respondents utilized their gardens. The main production of annual crops was rice and nilam, while, coffee, cacao and coconut were mainly planted in tree-based field. Yearly income generated by the groups was not significantly different, however, the highest proportion of families who spent above 80% for food was found among tree-based crop farmers, followed by non-farmer because they did not cultivate food crops. The women and children in all groups suffered chronic undernutrition indicated by high prevalence of overweight/obese women, stunting and underweight among children. Similarly, anemia prevalence in all sub-sample women was also high. Prevalence of wasted children in the tree-based crop farmer families was the highest (26.5%), followed by non-farmer. Tree-based crop farmers suffer more severely due to food insecurity as compared to the other groups. Recommended actions for tackling the food insecurity are promoting mixed systems among the tree-based crop farmers, better use of homegarden for planting crops or trees as source of food, as well as nutrition rehabilitation for the undernourished women and children.

Keywords

Central Sulawesi-Indonesia, diet diversity, food security, nutritional status, smallholder farming systems

Acknowledgements

This study is a joint-collaboration between the Faculty of Medicine, Nutrition Department, University of Brawijaya, Malang, Indonesia, and the Institute of Biological Chemistry and Nutrition, University of Hohenheim, Stuttgart, Germany, and the World Agroforestry Centre/ICRAF, funded by International Fund for Agricultural Development (IFAD) through the Climate-Smart, Tree-Based, Co-Investment in Adaptation and Mitigation in Asia project (Smart Tree-Invest). We would like to acknowledge the enumerators who helped in collecting data in the field. We also appreciate the logistical support from Mief Qur'anin Setyohadi, S. Gz, Riska Mayang, S.Gz. during data collection. We are particularly thankful to the communities of Kokobuka, Lomuli, Air Terang, Boilan, Balau, Taat, Matinan, Lokodidi, Pomayagon, Guamonial and Wakat who have participated in our activities and enthusiastically shared with us their views and life experiences. We gratefully acknowledge the support from BAPPEDA Kabupaten Buol.

Acronyms

BMI	: Body Mass Index (kg/m^2)
FGD	: Focus Group Discussion
HAZ	: Height-for-age-z-score
Hb	: Haemoglobin
ICRAF	: International Center of Research in Agriculture
IDA	: Iron Deficiency Anemia
KII	: Key-informant In-depth Interview
MoHRI	: Ministry of Health the Republic of Indonesia
MUAC	: Mid-upper-arm circumference
NGO	: Non-governmental organization
SD	: Standard Deviation
VA	: Vitamin A
VAD	: Vitamin A Deficiency
WAZ	: Weight-for-age-z-score
WHO	: World Health Organization
WHZ	: Weight-for-Height-z-score

List of Definition

Anemia
A decrease of red blood cells or Hb in the blood. For children and pregnant women, Hb < 11 g/dl is categorized as anemia and Hb < 12 g/dl is classified as anemia for non-pregnant women.

BMI classification
Nutritional status classification for adult based on WHO

Non Pregnant Women Nutrition Status based on BMI	BMI
Underweight	≤ 18,49
Normal	18,50 - 24,99
Overweight / pre-obese	25,00 - 29,99
Obese 1	30,00 - 34,99
Obese 2	≥ 35

Community outreach worker/cadre
A voluntary worker that is actively searching for wasted children within the community, thus, not waiting until the wasted child seeks emergency assistance in a clinic/hospital.

Complementary feeding (WHO definition)
Complementary feeding is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk.

Stunting
HAZ<-2 SD is categorized as stunting, while HAZ <-3 SD is classified as severe wasting. Stunting is often associated with the accumulated consequences of slowed skeletal growth and with long-term dietary inadequacy, repeated infectious disease or both. Furthermore, stunting is regarded as an index of poverty and deprivation. It is commonly used as an indicator of nutritional outcomes for a longer period of intervention.

Supplementary feeding program (WHO definition)
The provision of extra food to children or families beyond the normal ration of their home diets. Moreover, it can take place in the home, feeding centers, healthcare centers, and schools.

Underweight (for children)
WAZ<-2 SD is categorized as underweight, while WAZ <-3 SD is defined as severely underweight. Underweight indicates the presence of both acute (wasting) and chronic malnutrition (stunting) in a child. Therefore, the cause may be not only acute illness but also inadequate history food intake.

Wasting
WHZ<-2 SD is defined as wasting, while WHZ <-3 SD is categorized as severe wasting. Wasting indicates that a child has excessively low body tissue and fat mass according to his/her height, which can be a result of either acute weight loss or failure to gain weight. Under the conditions of inadequate food intake, its onset can occur rapidly, particularly during acute illness. Wasting is a common indicator of nutritional status of children under-five in loud and silent emergency situations.

Contents

List of figures

List of tables

1 Introduction

Representing 85% of the world's farms and contributing at least 70% of world's food (Harvey et al 2014), smallholder farmers constitute a significant portion of the world's population. Ironically, smallholder farmers are also estimated to represent half of the hungry people worldwide (Sanchez and Swaminathan 2005). The food security of smallholder farmers primarily depends on local agricultural productivity and food purchasing power. Consequently, smallholder farmers are vulnerable to food insecurity, any constraints on agricultural productivity or income will influence diet diversity and ultimately the nutritional status of the farmers (Headey and Ecker 2013; Johnston et al 2014).

Indonesia, the fourth-most populous country in the world, is home to 22 million under-nourished people. In 2017 The Global Food Security Index ranked Indonesia as 69 out of 108 countries with the score of 51.3 based on food affordability, availability, quality and safety (The Economist Intelligence Unit 2017), an improvement from the score of 46.7 and ranked 74 in 2015. The large geographical variation of Indonesia manifest in significant variation of dietary patterns reflecting local availability and cultural differences. According to Ickowitz et al (2016) there is a relationship between different tree-dominated landscape and consumption of micronutrient-rich foods across Indonesia. Using national level aggregate studies, the paper suggested that forest and tree-based systems could play an important role in supporting dietary quality in Indonesia. However, details at local level may differ due to specificity of land use policies, type of tree-based systems and cultures. Hence, further research is needed to understand the exact mechanisms and the regional differences.

This study aims to provide further detail on the relationship between trees and food security in Indonesia. We surveyed communities managing different type of farming systems (crop and tree-based systems) in Buol Regency, Central Sulawesi, one of the low-income province in Indonesia with the objectives to explore if the farming systems they managed influenced their household income, food expenditure, diet diversity and nutritional status. We focused on the nutritional status of women and children as the most vulnerable group in the community.

2. Concepts and Methods

2.1 Conceptual framework

The 1996 World Food Summit defined food security as '… when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.'. Based on this definition, there are 4 dimension of food security: availability, access, utilization and stability that must be met simultaneously.

Food availability, the first aspect of food security is achieved when adequate food is available, either from domestic production or trades. An adequate supply of food does not guarantee household food security. It will depend on household access to have sufficient resources in getting adequate nutritious foods that originated from farm production, purchase or donation. Through nutritious and safe diets, an adequate biological and social environment, as well as proper health care, utilization of food can be accomplished. Utilization encompass both the aspects of food (adequate diet, clean water) and non-food (sanitation and health care) items. Stability refers to the condition when all the three components

of food security: availability, access and utilization are acquired always. Inadequate access, utilization and unavailability of food for a periodic of time is consider as food insecurity. The four pillars of food and nutrition security are finally manifested in the nutritional status of the individual people (Maxwell and Smith 1992; Gross et al 2000, FAO 2006; Gartaula et al 2016).

Besides the complex relationship between agricultural production and nutritional status of farmer family members (Masset et al 2011), the Indonesian Ministry of Health (MoHRI) reported that farmers were considered as the vulnerable group due to their monthly expenses being in the lowest quintile of the distribution and having the highest prevalence of stunted children (MoHRI 2010), which made the necessity in understanding the farmer family situation.

The conceptual framework of the study (Figure 1) was developed based on UNICEF (1998), Gross et al (2000) and Masset et al (2011) The framework described that agricultural production leads to improved food accessibility indicated by the economic situation and dietary diversity of the family. The provided/consumed foods were converted into macro and micronutrient intake, which determine the nutritional status of the women and their children below five years old of age. In this framework, caring aspects play an important role on the nutritional status of the women and their children through its influence on the feeding practices as well as hygiene behaviour, sanitation and health care utilization.

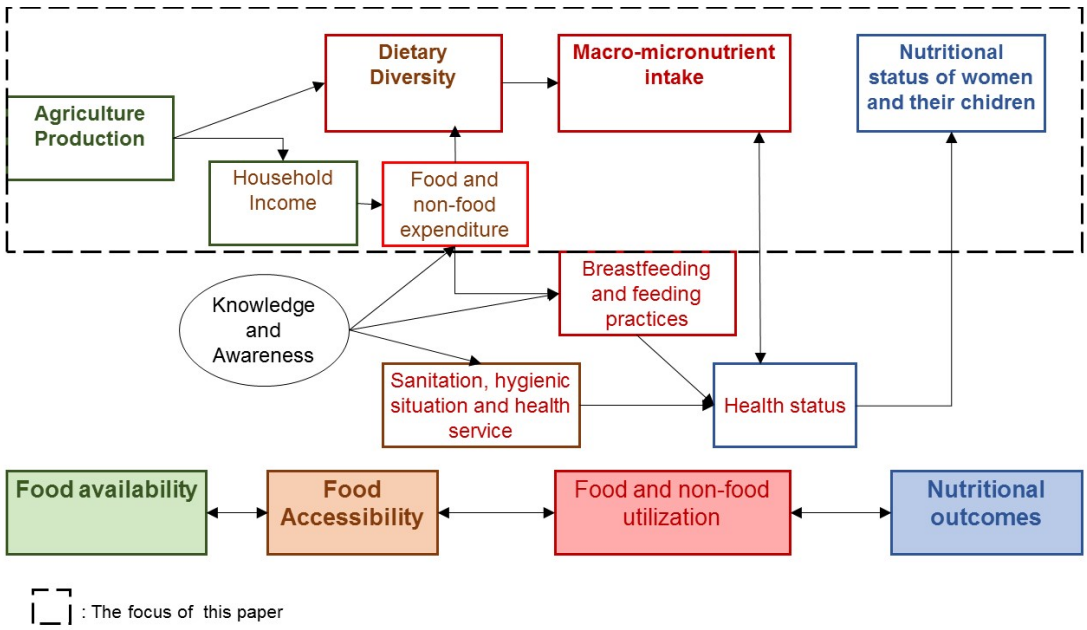


Figure 1. The conceptual framework of the food security and nutritional study in Buol.

This paper focuses on how agriculture production and household income influence dietary diversity that leads to nutritional status of the women and children.

2.2 Location and population under study

Buol is a district situated in the northern part of Central Sulawesi, roughly 806 km or an 18-hour drive from Palu, the province's capital city. The total area is approximately 3,562 km^2. Buol's land use varies considerably, ranging from mountainous forests in the south to tree-based systems and agriculture in the centre, and mangrove ecosystems along the coastal areas in the north. The main

tree-based systems managed by farmers were complex agroforestry systems, and clove, teak, and coconut plantations, while the main agriculture systems are irrigated paddies and dryland agriculture, including maize and vegetables (Wijaya et al 2015). The Human Development Index (HDI) of the provinces in Sulawesi is lower than the national average. In 2011, the national HDI average was 78.9, whereas for Central Sulawesi's was 71.6, ranking 22 of the 34 provinces of Indonesia. The life expectancy for Central Sulawesi was 68.9, which is below the national average of 69.8, while the region's economic growth for 2006–2010 was 8.18%. The total gross domestic product (GDP) of Buol was USD 175,348 in 2012 or USD 1.3 per capita per day, which is lower than the province's average of USD 1.9 per capita per day. The population density in the sub-districts ranges from 7–134 km^2 with an average of 24 km^2.

Our present study is carried out in 11 villages from sub-district of Tiloan, Gadung and Momunu that represent the socio-ecological condition of villages in the regency (Table 1).

Table 1. General characteristics of the villages sampled in this study.

Sub-district	Location	Village	Agricultural systems	Community type	Main livelihood options	Environmental issues	Access
Tiloan	Upland, Upstream	Kokobuka Lomuli	annual crops (maize, rice, vegetables, tubers) timber systems cacao systems (mostly abandoned)	Transmigrant[1], mostly from Java and Bali	Agricultural activities	Lack of water for irrigation, erosion in newly opened oil palm plantation areas	Difficult, stone and dirt road, undulating terrain
	Upland, Midstream	Balau Boilan Air Terang	annual crops (maize, rice, vegetables, tubers) timber systems cacao systems	Mixed between transmigrant, from Java and Bali	Agricultural activities	Flooding, river bank collapse	Moderate, some parts of the road are in bad condition
Momunu	Lowland, swamp	Pomayagon Guamonial Wakat	Annual crops, sago (*Metroxylon sago*) systems, timber systems	Mostly local people, some spontaneous migrants from other areas in Sulawesi such as Gorontalo, and South and North Sulawesi	Agricultural activities, plantation worker	Flooding	Moderate too diffcullt, in some places access through canoe
Gadung	Coastal	Matinan Lokodidi Taat	cacao clove fruit trees (mixed systems) rice fields (few)	Local people, spontaneous migrants	Agricultural activities. Fishing and mining	Coastal vegetation degradation, coastal abrasion, increased sea water levels	Easy, along good-quality provincial road

[1] The transmigration programme in Indonesia (from Dutch, transmigratie) was an initiative of the Dutch colonial government, which was later continued by the Indonesian government to move landless people from densely populated areas of Indonesia Java to the other islands such as Sumatera, Kalimantan, Sulawesi, Papua that are less densely populated. People who participated in the programme are called the *transmigrants*.

2.3 Design of the study

Subjects of this study were women and their oldest under five children (aged between 6 and 60 months) living with at least one household member who were occupied as farmers. Farmers were grouped according to the type of cultivated plants, as follows annual, tree-based and mixed crops, with additional group of non-farmers for comparison.

A structured and quantitative questionnaire was used for data collection. Prior to the onset of the study, the questionnaire was pretested at the University of Hohenheim, Germany and in Buol district. During the data collection, mothers/caregivers of the eligible children were interviewed at home and asked about socio-demography and economy parameters (such as number of children, family size, household ownership and income), breastfeeding and child feeding practices. Then, the fathers were asked about agriculture related factors. The data for dietary intake of the children was collected by a 24-hour food intake recall as the basis of dietary diversity. Furthermore, heights of the women and children were measured, and their weights were determined using SECA 201 scale. Mid-upper arm circumference (MUAC) of the respondents were measured using MUAC tape (photo below).

Anthropometric assessment. Photo: Hohenheim University/Ratna Chrismiari Purwestri

Hb level of sub-sample women was assessed using hemocue. In addition, focus group discussions (FGDs) for farmers (N=5) and women (N=4), as well as several key informant in-depth interviews (KII) were carried out in selected villages in the three sub-districts to understand the agriculture situation, local food habits of the women and children. Qualitative data were recorded, noted, transcribed for further analysis and reported elsewhere.

2.4 Sample size

Based on calculation, a total sample size of 95 pairs of mothers and children was needed to detect differences in the area having a wasting prevalence of 6.4% in Central Sulawesi based on Indonesian Health Profile (National Intititute of Health Research and Development, 2011) with a confidence level of 95%. By multiplying with design effect of 2, total of sample size required was 190 pairs women and their children. Furthermore, a total sample size of 34 per group was calculated for detecting mean

Hb level difference of 0.55 with standard deviation of 0.8 (Awasthi et al 2003) or mean height-for-age Z-scores[2](HAZ) difference of 0.12 with standard deviation of 0.07 (Khomsan et al 2013).

2.5 Data analysis

Data analysis was performed, testing the relationship of family socio-economic and demographic situation, household expenditures, agricultural sector characteristics, dietary intake and nutritional status between groups.

Data was checked for conformance to a normal distribution using QQ-plots of normality ((Wilk and Gnanadesikan 1968). For normally distributed data, differences in means were tested with ANOVA, while for the non-normally distributed data Kruskal-Wallis test was used. Categorical data was analysis using Chi's square and Fischer exact test.

Statistical analysis was performed using IBM SPSS Statistics Version 22. Data on weight and height of the children were transformed to Z-scores using Emergency Nutrition Assessment version 2011 (ENA for SMART). Value larger than or equal to than two times standard deviations was considered as well-nourished, while value below of that standard was defined as undernourished (wasted, stunted or underweight). Body mass index (BMI) of the women were defined using a formula: weight (in kg)/ height2 (in m2). BMI below 18.5 was considered as underweight, 18.50-24.99 was normal weight, above 25 was categorized as overweight and obese. Anemia was defined when pregnant woman has Hb-level lower than 11 g/dl and non-pregnant woman has Hb-level lower than 12 g/dl.

3. Results

3.1 Respondents profile

A total of 200 under-five children and their care givers were recruited in this study. Most of the caregivers were the mothers of the surveyed children with exception of three children who their care givers were their grandmothers. The main source of livelihood of the respondents were annual-crops (n=69), mixed-crops (n=55), tree-based crops (n=34) and non-farmer (n=42).

Nearly all the farmer respondents were the father; only about 3-6% of them were the grandparents of the under-five children. Annual-crop farmers were considered the second oldest after the tree-based crop farmers, had significantly higher percentage of low education level (schooling ≤ 6 years), were from Javanese (>40%) and Buol (>26%) ethnic group. Most of the annual-crop farmers also owned their own house as compared to the other groups. More than 80% of the tree-based crop farmers were originally from Buol, while the mix-crop farmers were mostly from Buol and Java. About half of the tree-based and mix-crop farmers had low education level, and their average household size was more than four persons. Tree-based households had the highest number of children followed by mixed crop. In contrast, the non-farmer group had the lowest proportion of schooling ≤ 6 years, but the other indicators were comparable to other groups. Similar trends were found among mothers in all groups (Table 2). More than 80% of the tree-based crop farmers were originally from Buol, while the mix-

[2] Height-for-age Z-scores is a standard indicator of growth used by the World Health Organization (WHO) for nutritional status (Mei and Grummer-Strawn 2007).

crop farmers were mostly from Buol and Java. About half of the tree-based and mix-crop farmers had low education level, and their average household size was more than four persons. Tree-based households had the highest number of children followed by mixed crop. In contrast, the non-farmer group had the lowest proportion of schooling ≤ 6 years, but the other indicators were comparable to other groups. Similar trends were found among mothers in all groups.

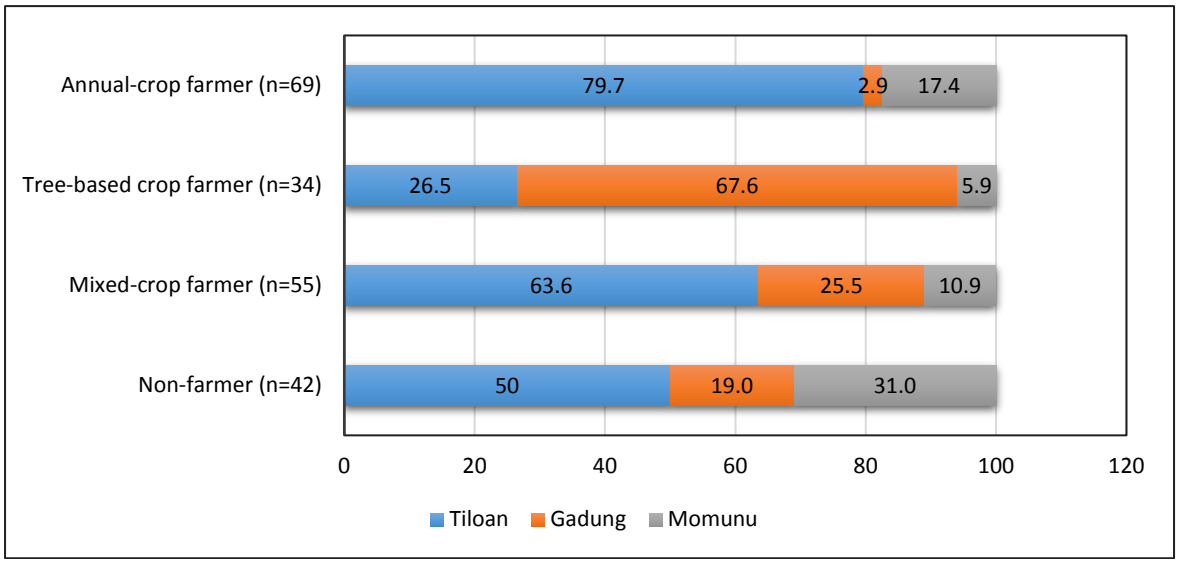


Figure 2. Residential of the respondents by groups

Table 2. General characteristics of respondents by farmers type.

Characteristics	Farmer			Non-farmer (n=42)
	Annual-crop (n=69)	Tree-based crop (n=34)	Mixed-crop (n=55)	
Age (years)				
Father	34.0±12.2	36.0±10.4	35.9±7.7	33.5±7.8
Mother	29.6±6.7	31.6±6.5	30.5±7.5	30.3±7.3
Education level (<= 6 years of schooling)				
Father (%)	66.7	44.1	50.9	35.7
Mother (%)	62.3	50.0	54.5	28.6
Presence in the house (Yes)				
Father	94.2	97.1	100.0	100.0
Mother	100.0	100.0	100.0	100.0
Household size				
> 4 members (%)	40.6	73.5	56.4	54.8
Range	3-9	3-10	3-10	3-10
Number of children (range)				
All children	1-7	1-6	1-7	1-6
Under-five children	1-2	1-3	1-2	1-3
Housing ownership (%)				
Owned property	73.9	52.9	65.5	59.5
Parent's house	5.8	5.9	3.6	2.4
Patrimony	15.9	41.2	29.1	31.0
Family/other's house	5.8	5.9	3.6	2.4

On average 70% of all farmer groups still cultivated and depended on revenue from their agriculture production. Tree-based (17.6%), mixed- (25.4%) and annual-crop farmers (27.5%) worked as farm-worker or casual workers (on daily basis wages) to supplement their income. Approximately 61.8% of tree-based crop farmers had a second job, followed by mixed- (52.7%) and annual-crop farmers (43.4%). For non-farmers, 40% of them were employed by government or private company, about 20% self-employed or seller and 28% were farm-workers (with no land). Many of them worked at the private palm-oil company. About three of them owned farmland, but did not cultivate instead depending on wages farm-work.

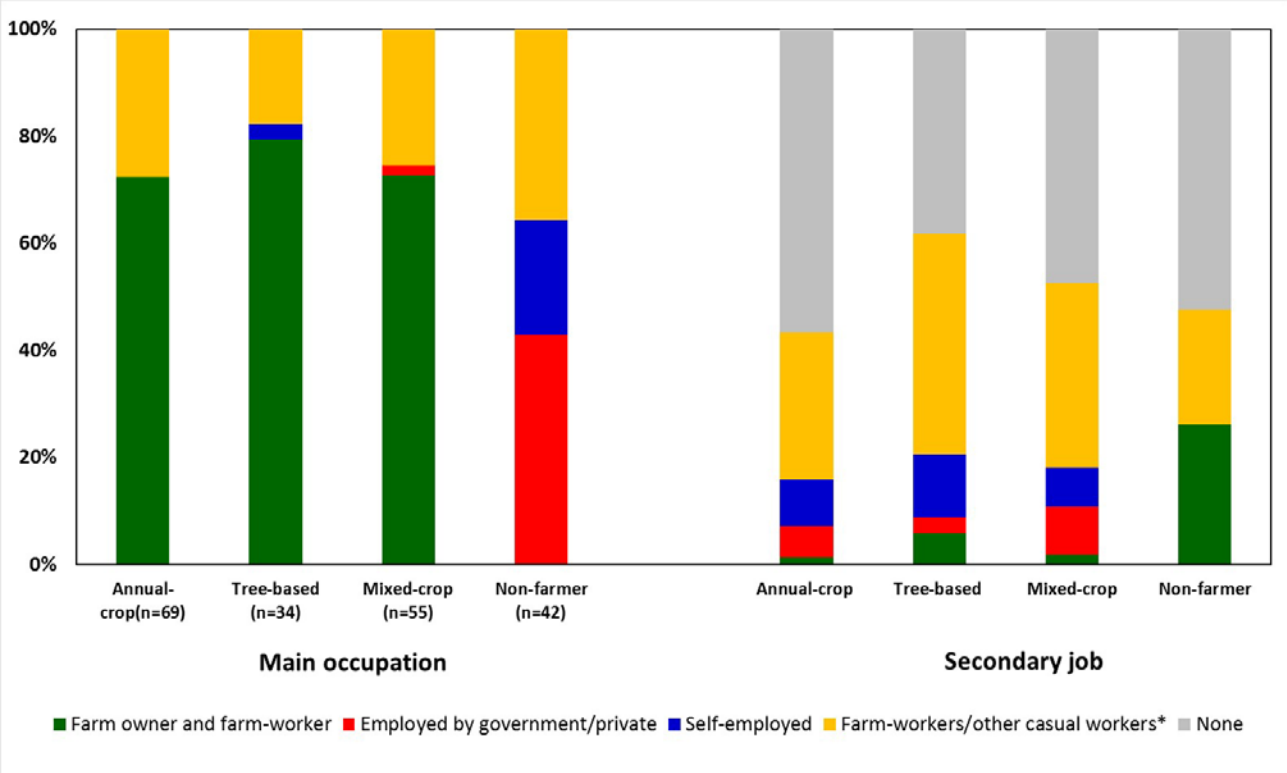


Figure 3. Main occupation and secondary employment of the farmers. Casual workers include carpenter, building construction worker, sand and gold miner.

More than 80% of women in the three farmer groups were housewives. About 3-6% of them were farmers, farm worker, self-employed or employed by the government/private company. In contrast, 19% of women from non-farmer group were employed, followed by 2.4% and 7.1% of the women were self-employed and worked as farm-worker respectively.

3.2 Farming systems: plant diversity and productivity

In general. There are four types of field managed by farmers in Buol: homegarden, paddy-field, dryland field and tree-based syetems. Homegarden is field or yard around the farmers home. Paddy field or *sawah* is a specific term for field planted with rice and always in inundated condition. Dryland field or *ladang* is define as non-irrigated field/plots, typically located further from home and planted with annual or perennial crops. *Kebun* or tree based systems also located far from home and is non-irrigated. Nearly all respondents had homegarden, excluding those who rented /borrowed their houses. However, in Buol less than 50% of them utilized and specifically planted the field. In general, plants

in homegarden are for own consumption while plants in dryland field are for commercial and own consumption (Table 3). Rahayu et al (2015) provides further information on plant species found in farming systems in Buol.

The largest median homegarden size belonged to mixed-crop farmer group (390 m^2), followed by annual-crop (360 m2), non-farmers (254 m2), and the smallest was tree-based crop farmers. Mixed-crop farmers were found to own more fields than annual-crop farmers (Figure 4). Different kinds of fruits were commonly planted in homegarden (Table 3), by tree-based (36.7%) and mixed-crop farmers (37.7%).

Table 3. Plant species typically found in the various land use systems found in Buol.

Land use type	Plant species
Homegarden	Tree fruits: rambutan (*Nephelium lappaceum*), mango (*Mangivera* sp), guava (*Psidium guajava*), papaya (*Carica papaya*), banana (Musa sp.), orange (*Citrus* sp), jackfruit (*Artocarpus heterophyllus*)
Dryland field (*ladang*)	Food crops: maize (*Zea mays*), rice (*Oryza sativa)*, eggplant (*Solanum melongena*), chilli pepper (*Capsicum* sp) Perennial crops: patchouli (*Pogostemon cablin*)
Tree-based (*kebun*)	Tree-crops: coffee (*Coffea arabica*), cacao (*Theobroma cacao*), coconut (*Cocos nucifera*) Tree fruits: durian (*Durio Zibethinus*), mango (*Mangivera* sp), rambutan (*Nephelium lappaceum*), clove (*Syzigium aromaticum*), duku (*Lansium domesticum*), pala (*Myristica fragrans*) Timber trees: teak (*Tectona grandis*), jabon (*Anthocephalus chinensis*), nantu (*Palaquium obtusifolium*)

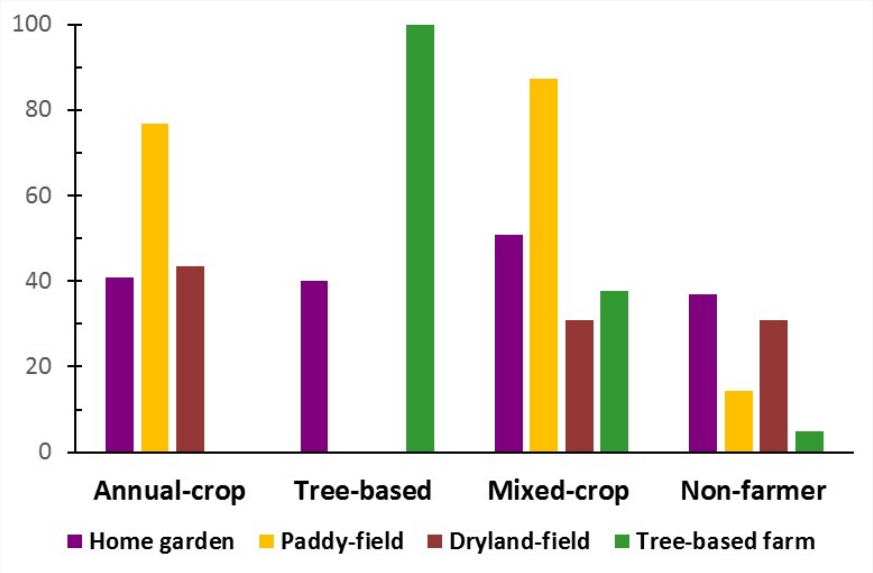


Figure 4. Land ownership of the respondents by group

Paddy fields were owned mostly by annual and mixed-crop farmers (Figure 4). Rice varieties commonly cultivated in the study area were Mekongga and Limboto. Half of the rice farmers produced for own consumption. Mixed and annual-crop farmers significantly consumed their

cultivated rice production more than that of non-farmers and many farmers consumed and sold their rice (Table 4).

The size of dryland field was in the range of 0.5 to 1.0 ha. Most farmers cultivated food crops in their field (Table 4). Recently patchouli became a popular perennial crop due to its high price. The leaves were processed for oil used in perfume making. Many farmers were converting their unproductive cacao field to patchouli. Unfortunately, the price of patchouli is unstable, leaving many farmers disappointed.

Table 4 presents the main crops produced in the study area. Rice production was dominant among the annual-crop farmers, in terms of its production and revenue almost matched by patchouli planted by mixed-crop farmers. Rice was planted mainly for own consumption, while patchouli purely for commercial purpose.

In the tree-based systems, cacao has higher productivity than clove. However, revenue derived from clove is higher than cacao. Other trees that were cultivated in this system were coconut, jati and various fruits trees. Qualitative results revealed that main crop production had decreased 20-30 percent due to the long drought season in 2015. Therefore, it was likely that the 2015 production was lower than the usual production

Table 4. Agriculture production in the study area.

Characteristics	**Farmer**			**Non-farmer (n=42)**
	Annual-crop (n=69)	**Tree-based crop (n=34)**	**Mixed- crop (n=55)**	
Rice (n)	49		46	6
Land size (ha) – median - 1st quantile, 3rd quantile	0.50 (0.25, 0.75)		0.50 (0.13, 0.97)	0.23 (0.11; 0.47)
Purposes				
- for own consumption	93.9 (46)		93.5 (43)	83.3 (5)
- for sale	87.8 (43)		56.5 (26)	60.0 (3)
- for other uses[2]	34.7 (17)		39.1 (18)	60.0 (3)
Production (in quintal/year)	12.0 (6.8; 22.5)		8.5 (3.1; 30.0)	4.0 (2.8; 5.0)
- for own consumption (in quintal/year)	2.4 (1.5; 4.5)		3.0 (1.5; 40.0)	1.9 (1.1; 3.3)
- for sale	10.0 (3.5; 20.0)		4.3 (0.1; 16.9)	1.0 (0.1; 2.9)
- for seeding	0.0 (0.0; 0.2)		0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
- for other uses	0.0 (0.0; 1.0)		0.0 (0.0; 1.8)	0.4 (0.1; 1.4)
Revenue from rice sales (n)	43		26	3
- Total (in million Rp/year)	10.2 (0.5; 18.0)		4.5 (0.01; 21.1)	1.0 (0.01; 4.6)
Patchouli	14		10	
Purposes				
- for sale	100.0 (14)		100.0 (10)	
- for seeding	0.07 (1)		0.0 (0)	
- for other uses	0.07 (1)		0.0 (0)	
Production (in quintal/year)	18.0 (2.5; 22.5)		10.0 (0.3; 25.0)	
- for sale (in kg/year)	13.5 (2.5; 22.5)		10.0 (0.3; 25.0)	
Revenue from nilam sales (n)	14		10	
- Total (in million Rp/year)	6.7 (2.5; 13.0)		9.0 (3.3; 26.6)	
Cacao	1	14	27	6
Production (in quintal/year/ha)	9.6	2.9 (1.2, 10.0)	2.2 (0.7; 6.0)	4.6 (1.4: 14.1)
Revenue from cacao sale (n)	1	14	27	6
- Total (in million Rp/year)	23.0	5.9 (2.8; 20.7)	4.3 (1.5; 14.0)	18.2 (3.5; 33.8)

Clove	16	10	3
Production (in quintal/year)	0.4 (0.04; 2.2)	0.6 (0.1; 1.1)	0.4 (0.1; 0.5)
Revenue from clove sale (n)	16	10	3
- Total (in million Rp/year)	14.9 (5.9; 28.0)	6.1 (0.9; 11.1)	5.4 (1.0; 5.5)
Coconut	5	8	3
Production (in quintal/year)	0.4 (0.1; 3.5)	8.7 (0.2; 15.0)	4.5 (3.0; 80.0)
Revenue from coconut sale (n)	5	8	3
- Total (in million Rp/year)	1.6 (0.6; 18,1)	5.7 (0.2; 14.0)	2.7 (1.2; 24.7)

Note: Data are presented in median (25^{th}; 75^{th}) or % (n).

3.3 Household income and expenditure

Table 5. Household income and expenditure per year[1]

Characteristics (in million Rp)	Farmer			Non-farmer (n=42)
	Annual-crop (n=69)	Tree-based crop (n=34)	Mixed- crop (n=55)	
Yearly total income	17.9 (13.1; 30.3)[a]	23.3(15.2; 47.6)[a]	24.2 (15.1; 42.0)[a]	22.6 (14.6; 48.6)[a]
Total yearly expenditures	15.5 (11.7; 21.7)[a]	18.2 (15.4; 25.8)[a]	18.7 (13.2; 27.7)[a]	19.5 (16.1; 28.3)[a]
- Agricultural activities	0.8 (0.1; 2.2)[a]	0.0 (0.0; 0.7)[b]	0.9 (0.3; 2.8)[a]	0.0 (0.0; 0.0)[b]
- Food	8.3 (6.0; 12.9)[a]	12.9 (9.6; 15.8)[b]	9.8 (5.8; 15.2)[a]	11.7 (7.6; 16.2)[b]
- Cigarette	1.1 (0.0; 2.4)[a]	1.3 (0.0; 2.6)[a]	1.1 (0.0; 3.6)[a]	2.0 (0.0; 3.7)[a]
- Transportation	0.9 (0; 1.6)[a]	0.1 (0.0; 2.1)[a]	1.0(0.0;1.6)[a]	1.0 (0.0; 1.6)[a]
- Health	0.0 (0.0; 0.08)[a]	0.0 (0.0; 0.05)[a]	0.0 (0.0; 0.04)[a]	0.0 (0.0; 0.03)[a]
- Education	0.0 (0.0; 0.06)[a]	0.0 (0.0; 0.1)[a]	0.0 (0.0; 0.1)[a]	0.0 (0.0; 0.07)[a]
- Housing facility	0.7 (0.4; 1.6)[a]	0.8 (0.4; 1.3)[a]	0.6 (0.3; 1.8)[a]	0.9 (0.2; 2.1)[a]
- Others	0.6 (0.4; 1.6)[a]	0.3 (0.07; 1.6)[a]	0.5 (0.2; 2.1)[a]	1.5 (0.02; 4.4)[a]

[1] Data are presented in median (25^{th}; 75^{th}) and analyzed using Kruskal Wallis test for the whole groups
Mean values with different letter in a row are significantly different as indicated by Mann-Whitney test.

Yearly total income was derived from different sources of income based on occupation, field ownership and crop production. In the study area, the yearly total income and expenditure of all groups was not significantly different. Mix-crop farmers spent more on agricultural activities than tree-based crop farmers and non-farmer group ($p=0.01$). Tree-based crop farmers had significantly high food expenditure ($p<0.001$) than the others, followed by non-farmers. After the conversion of yearly income to monthly income and comparison with 2016's regional minimum wage (Rp 1,670,000) set by the national government, the median monthly income of the household from annual-crop farmer group was below the minimum wage. However, when the total monthly food expenditure was categorized based on < and ≥80% as above and below poverty line, it was found that 26.5% of households in the tree-based crop farmer group were classified as poor, followed by non-farmer (16.7%), annual- (14.7%) and mix-crop farmer group (12.5%).

3.4 Dietary diversity and dietary intake factors

More than 30% of women from annual- and mix-crop farmer group consumed their own rice production, with above 60% of women purchasing rice in a retail store, in a weekly market, or from a vendor ('tukang sayur'). Almost all women in tree-based and non-farmer group bought rice. The second most consumed own-production crop was vegetable. The women also collected wild vegetables in the forest (e.g. spinach, swamp cabbage, etc). Animal-based foods that were mostly

consumed were fish/seafood and egg. Even though many of the farmers raised chicken, it seemed the main purpose was to sell. The following Figure 5 and Figure 6 showed that generally, the women in our study area consumed monotonous diet by consuming mostly rice and vegetables, sometimes with tempe/tofu or rice with fish (see also 6).

Table 6. Percentage and number of women that consumed the corresponding food groups

Food groups[1]	**Farmer**			**Non-farmer (n=42)**
	Annual-crop (n=69)	**Tree-based crop (n=34)**	**Mix- crop (n=55)**	
Cereals (rice)	100.0 (69)	100.0 (34)	100.0 (55)	100.0 (42)
Roots, tubers or other starchy	1.4 (1)	8.8 (3)	5.5 (3)	11.9 (5)
Vegetables	60.9 (42)	64.7 (22)	70.9 (39)	61.9 (26)
Fruit	37.7 (26)	47.1 (16)	36.4 (20)	47.6 (20)
Meat	5.8 (4)	5.9 (2)	9.3 (5)	9.5 (4)
Fish	42.0 (29)^{B}	88.2 (30)^{A,C,D}	60 (33)^{B}	59.5 (25)^{B}
Eggs	17.4 (12)^{c,d}	17.6 (6)^{c,d}	32.7 (18)^{a,b}	45.2 (19)^{a,b}
Pulses and legumes	37.7 (26) ^{b,d}	14.7 (5)	45.5 (25)^{b,d}	21.4 (9)
Dairy products	17.4 (12)	8.8 (3)	18.2 (10)	14.3 (6)
Oil	95.7 (66)	100.0 (34)	92.7 (51)	100.0 (42)
Median of consumed food groups	4	5	5	5
≤4 FAO/WFP food groups (%,n)	59.4 (41)	47.1 (16)	45.5 (25)	42.9 (18)

[1] Data is presented as % (n), or median (25th, 75th percentile) [2] Data was analyzed using Chi' square test (for categorical data) and Mann-Whitney test (for not normally continuous variables)
Significant level at p value < 0.001 with A: Annual-crop farmer, B: Tree-based crop farmer, C: Mix-crop farmer, D: Non-farmer
Significant level at p value < 0.05 with a: Annual-crop farmer, b: Tree-based crop farmer, c: Mix-crop farmer, d: Non-farmer

All respondents consumed mostly or solely rice, very few of them ate 'sago' as their staple food. The annual-crop farmers were found to consume the least diverse food (median:4), as compared to the other groups (median: 5), which made them more vulnerable to the changes in agriculture production (Table 6). Fish was commonly consumed among tree-based crop farmers because they lived mostly near coastal area. Pulses/nuts or tempe/tofu was a typical diet among annual- and mix-crop farmers, perhaps because most of them were originally from Javanese/Balinese transmigrants.

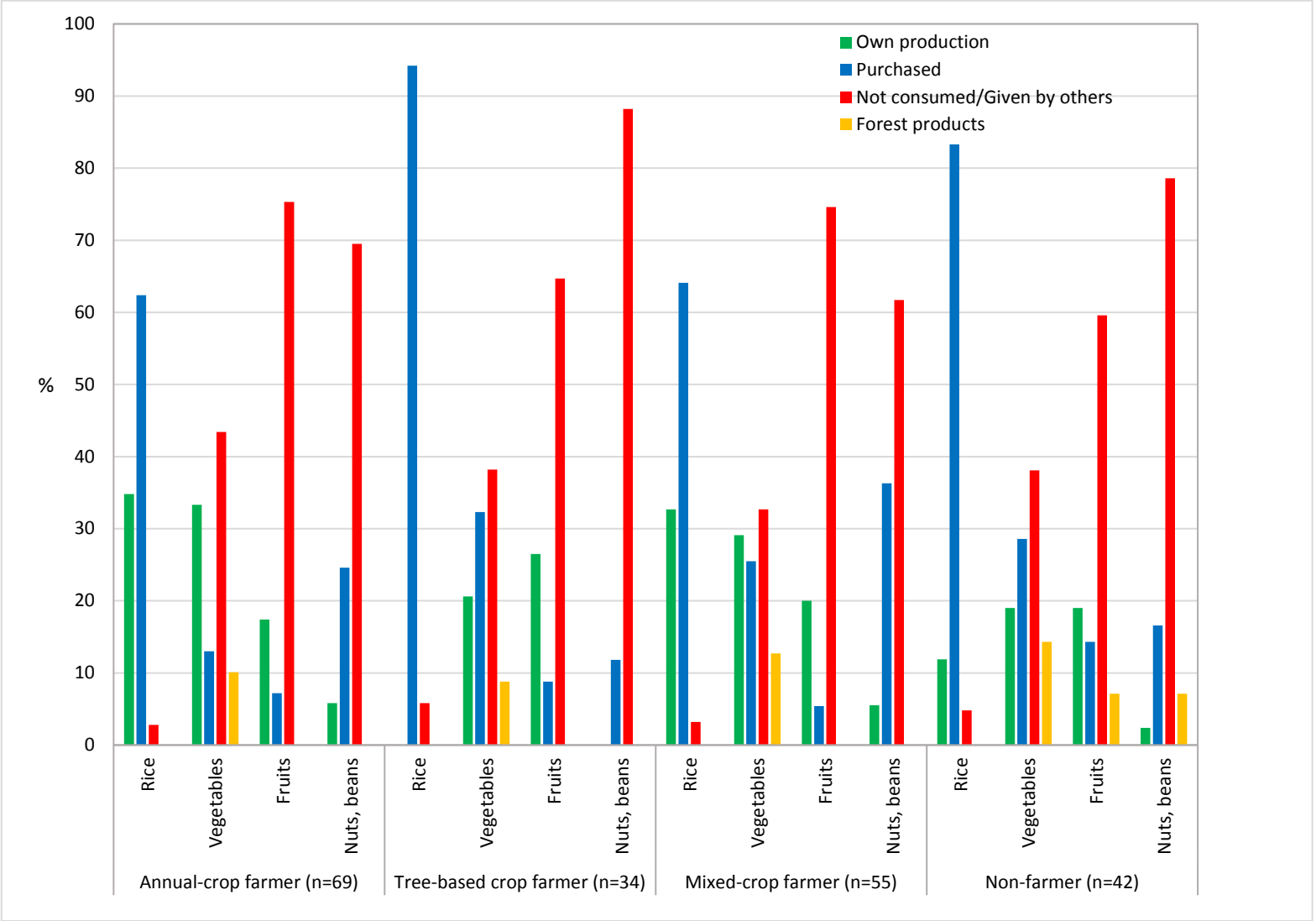


Figure 5. Plant-based food source in the study area

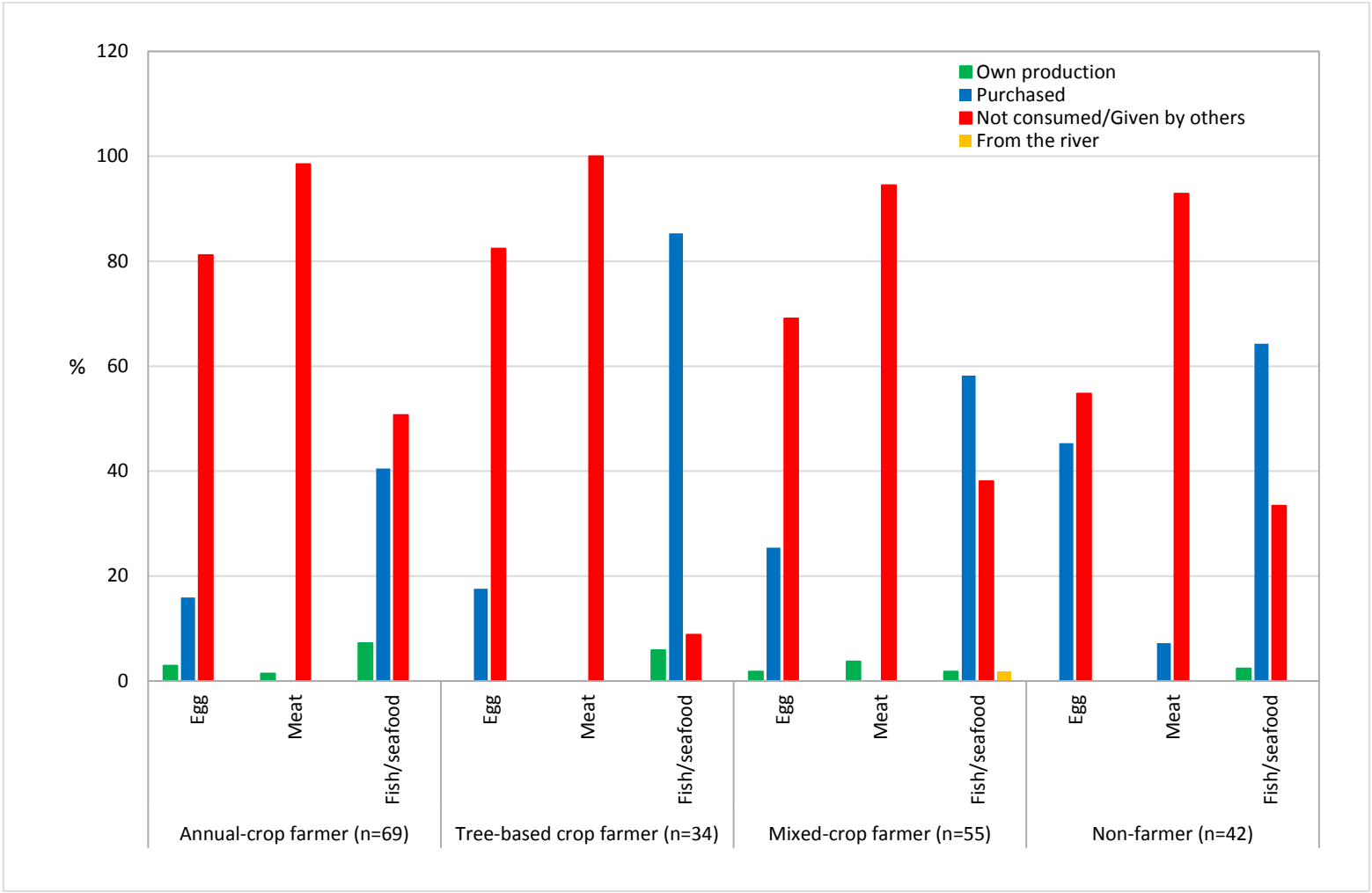


Figure 6. Animal-based food source in the study area

Percent-fulfilment of the selected nutrients from the women's habitual intake between groups was not significantly different. In total all women could fulfilled 50% of their energy requirement, while protein intake was between 57-67% of the Indonesian women recommended nutrients intake (Indonesia 2013). The lowest percent-fulfilment was found in iron intake of all women by ±13%. (Figure 13).

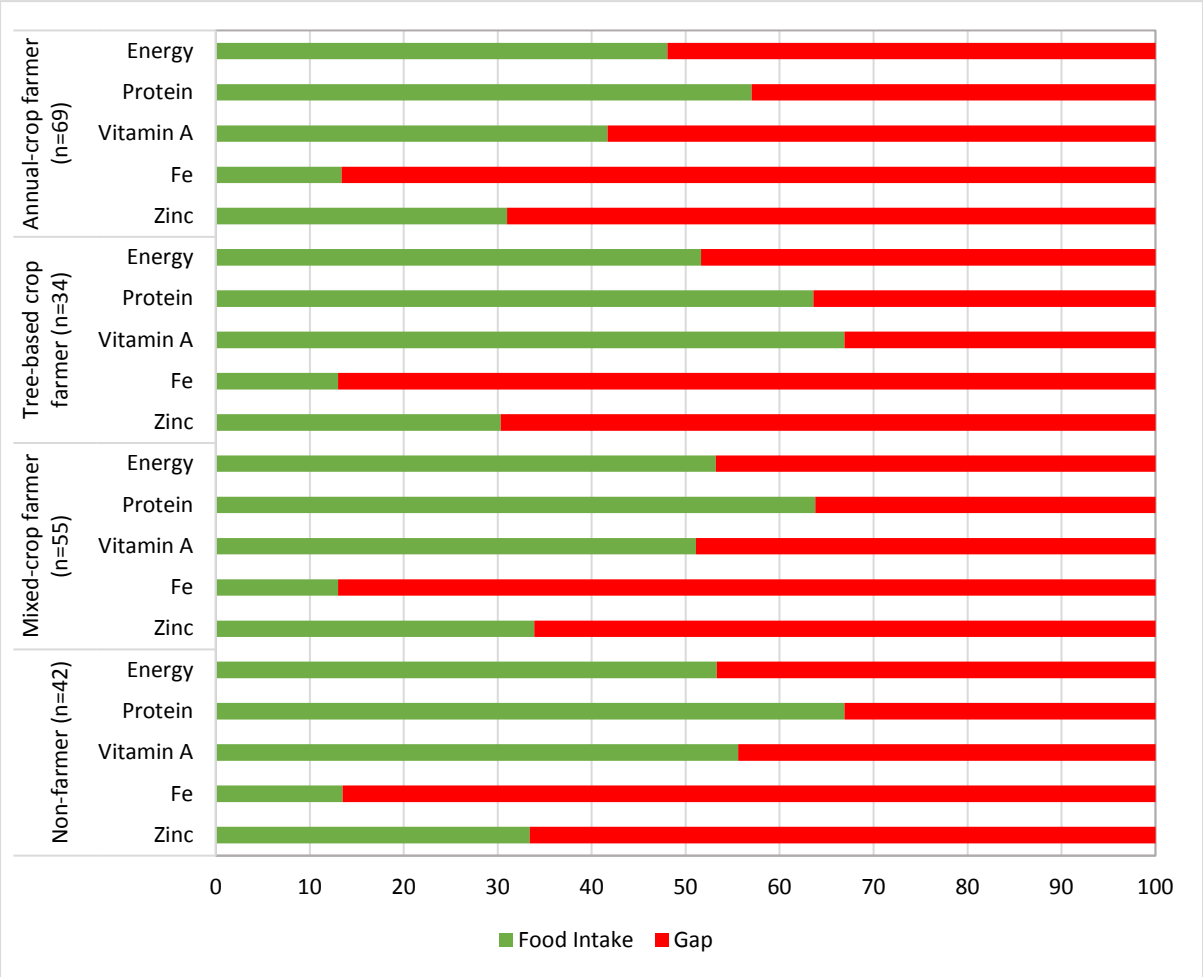


Figure 7. Intake fulfillment of selected nutrients from the women between groups

Of 200 under-five children, 74 of them were breastfed during survey period. Breastfeeding practices seemed to protect the breastfed children by approaching or exceeding their recommended intake (Ministry of Health Republic of Indonesia 2013), especially for energy and protein intake, in contrast to the non-breastfed children (Figure 8 a and b). Selected micronutrient intakes were lacking in all children.

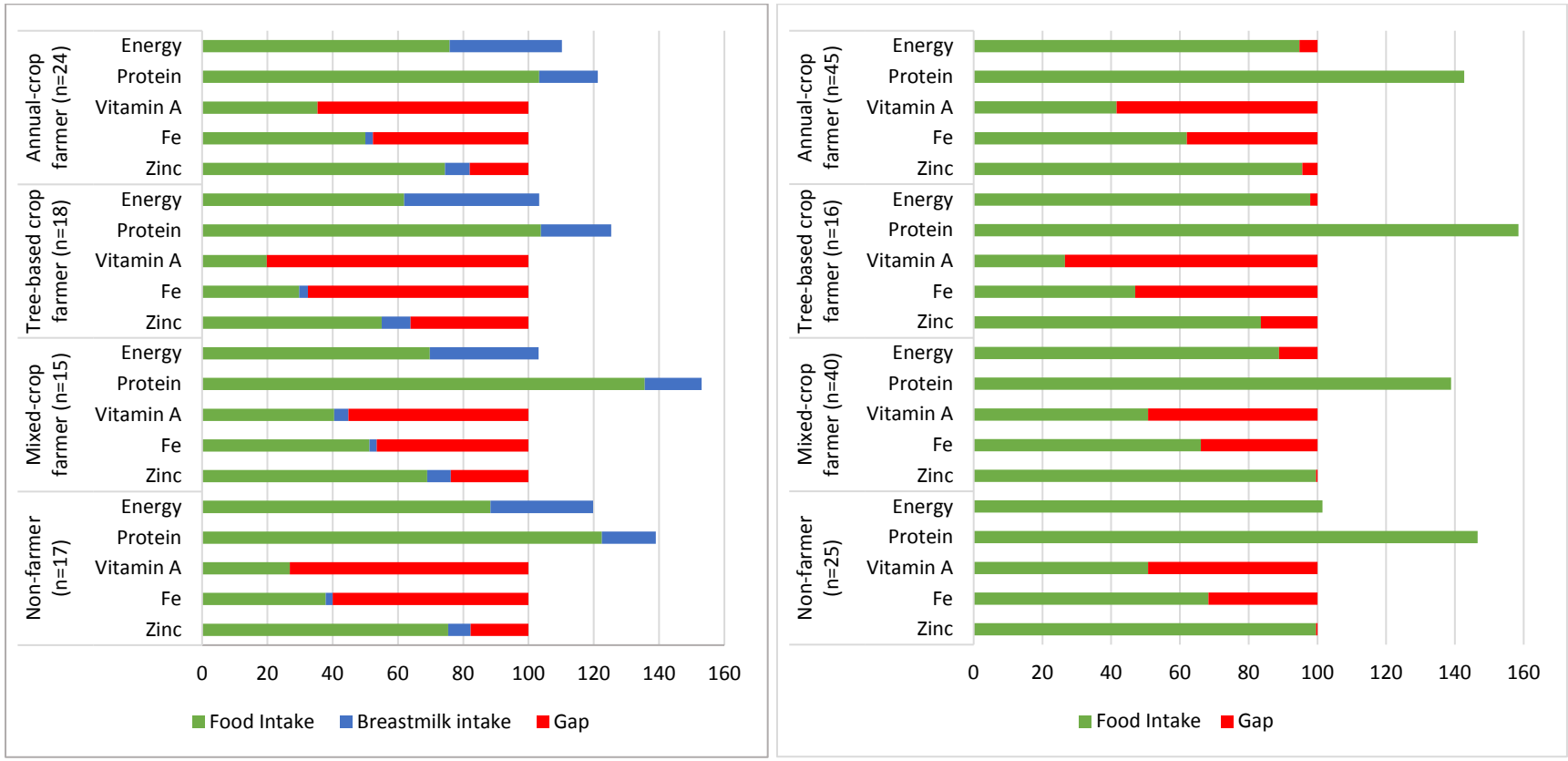


Figure 8. Intake fulfilment of breastfed (a) and non-breastfed children (b) by group

3.5 Characteristics and nutritional status of the women and children

Anthropometric characteristics of the mothers and children were similar between groups. as presented in Table 7.

Table 7. General characteristics of respondents by groups

Characteristics	Farmer			Non-farmer
	Annual-crop	Tree-based crop	Mixed- crop	
Eligible child, n	69	34	55	42
Age, mo	39.3±13.1	34.3±14.9	39.5±13.1	37.2±13.9
Girls, n (%)	47.8 (33)	55.9 (19)	50.9 (28)	52.4 (22)
Weight, kg	12.4±2.5	11.3±2.3	12.3±2.1	11.5±2.4
Height, cm	91.0±8.9	87.5±10.1	90.1±9.8	88.9±10.0
Women	69	34	55	42
Weight, kg	51.3±10.4	53.9±14.2	55.3±9.3	54.9±10.3
Height, cm	150.9±4.6	146.5±26.1	151.1±4.5	151.8±4.7
MUAC, cm	26.6±3.5	28.2±4.4	27.8±3.5	27.2±3.6
Subsample non-pregnant women	59	27	45	34
Hb level, g/dl	12.4±1.1	12.8±1.9	12.3±1.3	12.6±1.1

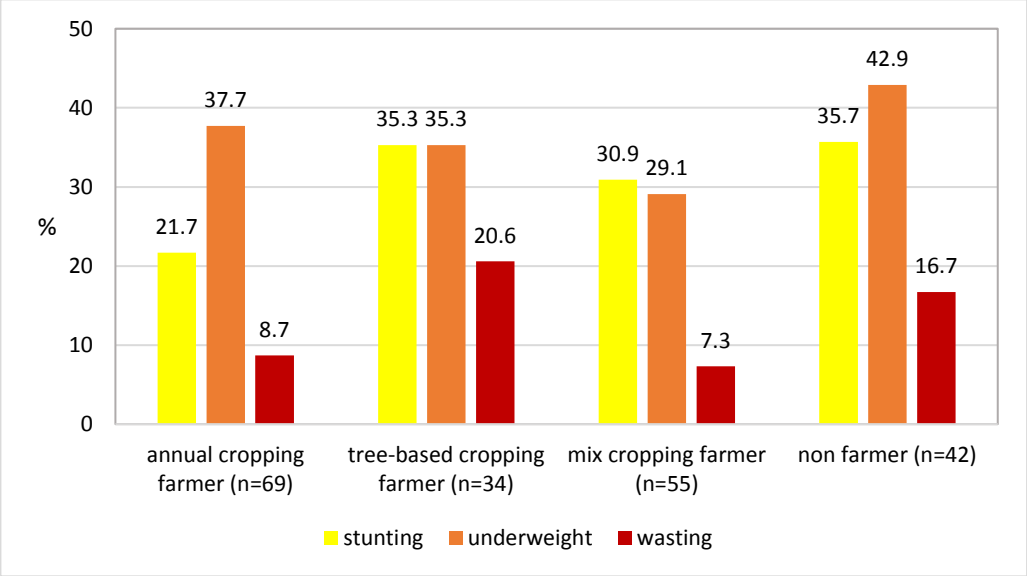
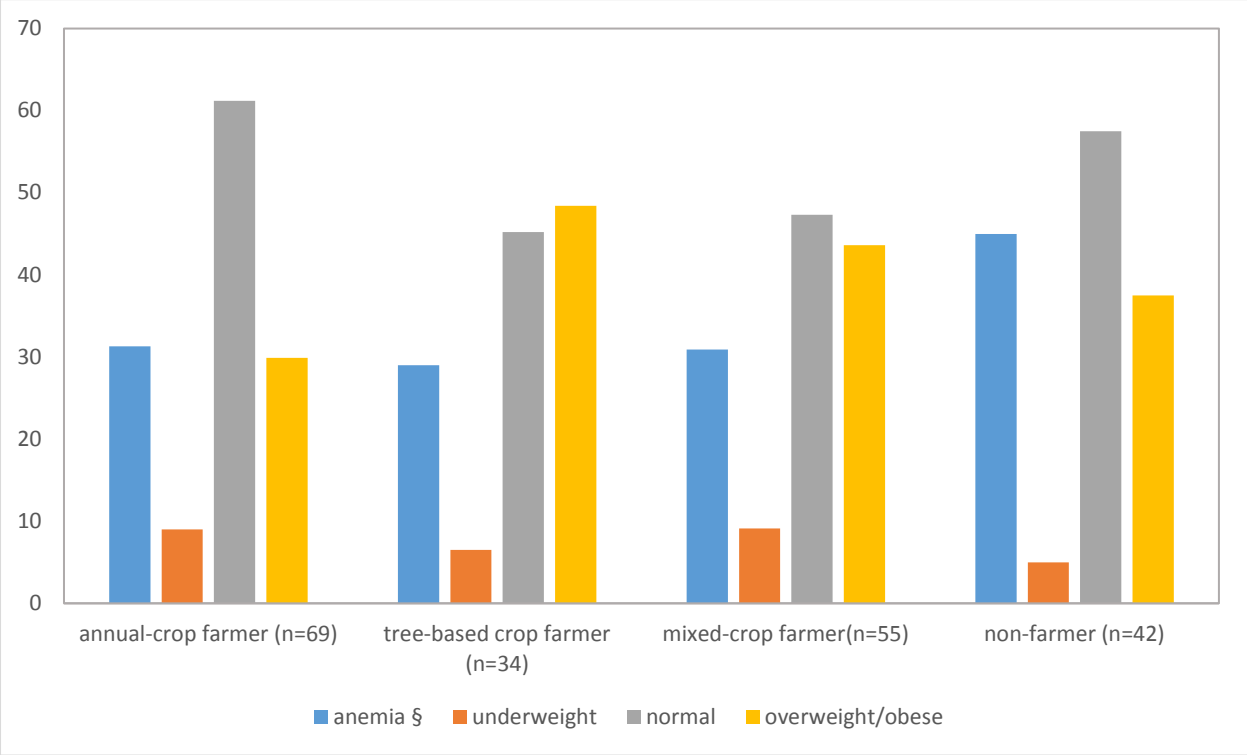


Figure 9. Nutritional status of the children by group

Anthropometric assessment is a method to draw conclusions about the nutritional status of individuals and populations by measuring part of the human body and comparing the measurement with international growth reference data. Weight and height are considered as the basic anthropometric measurements for growth indicators. This method is commonly used because of several advantages; it is non-invasive, inexpensive, and easy to obtain. However, it is important to accurately train field workers to get precise measurements. Weight-for-height Z-score/WHZ < -2 SD indicates wasting, weight-for-age Z-score/WAZ<-2 SD defined as underweight, while height-for-age Z-score/HAZ<-2 SD is categorized as stunting (WHO 1995).

Prevalence of underweight and stunted children were very high in all groups; they were all above 20% and 30% for underweight and stunted children (WHO 1995). This showed that they suffered from a chronic food insecurity. Prevalence of wasted children from tree-based crop and non-farmer was considered an alarming situation (above 10%) (WHO 1995); they experienced acute food shortage as shown in Figure 15. Prevalence of overweight/obese women in the study area was strikingly high. Even among tree-based crop households, the proportion of overweight/obese women exceeded the normal weight BMI (Figure 10). At the same time, prevalence of underweight women still existed, particularly among women from annual- and mix-crop farmer households (9%), which made them more vulnerable to the weather changes. Although no statistical significant different was found between groups, a high anemia prevalence (above 29%) indicated by Hb level below 12 g/dl among non-pregnant women was found, especially among non-farmer women (45%).

Nutritional status of the women and children in the study area indicated that the women suffered from acute and chronic malnutrition. This was aggravated by long drought season. The situation hit not only farmer households but also the non-farmer households in the study area.



§ anemia (subsample): annual-crop (n=59), tree-based (n=27), mixed-crop (n=45), non-farmer (n=34)

Figure 10. Nutritional status of the non-pregnant women based on BMI and anemia status

In this study, we found seven pregnant women who were analysed separately. Out of the seven, three were considered underweight according to MUAC categorization, and five were anaemic, indicating the need for immediate nutrition intervention to improving nutritional status of the pregnant women.

4. Discussion

4.1 Food security in Buol District

Mixed-crop farmers were found to own more fields the other groups and larger land size. In addition to planting tree-based (cash) crops, the mixed-crop farmers also cultivate food crops (rice and various fruits) in their fields enable them to be more food secure in respect to food availability.

Income and expenditure are used as proxies to food accessibility. In the study area, the tree-based crop farmers had significantly higher food expenditure ($p<0.001$) followed by non-farmers. The high cost on food was likely because tree-based crop and non-farmers did not plant food crops, therefore the income they received was utilized for buying foods. Even, the highest proportion of poor families indicated by monthly food expenditure $\geq 80\%$.

In terms of nutritional status, prevalence of underweight and stunted children was very high in all groups; they were all above 20% and 30% for underweight and stunted children (World Health Organization 1995), which showed that they suffered from a chronic food insecurity. Furthermore, prevalence of wasted children from tree-based and non-farmer was considered an alarming situation (above 10%). They experienced acute food shortage. Wasting indicates that a child has excessively low body tissue and fat mass based on his/her height, which can be a result of either acute weight loss or failure to gain weight. Under conditions of inadequate food intake, its onset can occur rapidly, particularly during acute illness. However, this condition is only temporary. Nutritious food, hygienic feeding preparation for children, improved sanitation and better care from mothers or the main care taker will help the child to regain weight and catch up in growth. Wasting is a common indicator of nutritional outcomes of under-five children and it represent a silent warning of an emergency situations. In 2005, wasting among children (WHZ < -2 SD) resulted in about 14.6% or about 1.5 million of all children' death globally. Severe wasting (WHZ < -3 SD) also accounted for 4.4% mortality of the children under five years old (Black et al 2008). Stunting signifies the accumulated consequences of slowed skeletal growth often associated with long-term dietary inadequacy, repeated infectious disease or both (Gibson 2005). Growth failure in the first 2 years of life leads to reduced adult stature, low school enrolment, and reduced adult income. The stunted children have an increased risk of suffering from overweight/obese and chronic degenerative diseases in the later life. The stunted women also have a increased risk of giving birth to low birthweight babies. The babies are not only associated with higher risk of neonatal mortality but also with poor child growth and development; thus, the vicious cycle of undernutrition is continued (UNICEF 1998; Victora et al 2008). Stunting is generally regarded as an index of poverty and deprivation; indeed, it is more frequently found under poor economic conditions. Therefore, stunting is commonly used as an indicator of nutritional outcomes of a long-term intervention project. Underweight indicates the presence of both acute (wasting) and chronic malnutrition (stunting) in a child, so the cause may not only cause acute illness but also poor food intake history (Gibson 2005).

The women in our study area consumed monotonous diet by consuming mostly rice and vegetables, sometimes with tempe/tofu or rice with fish, similar to the study carried out by Jati et al (2012). In total all of the women could only fulfilled 50% of their energy and 57-67% of their protein intake using Indonesian women recommended nutrients intake. This chronic inadequate dietary intake may

have resulted from the long drought season. In contrast, overweight/obese prevalence among women was also very high, which might be due to the impact of small stature among women (±146–151 cm) causing them to be more vulnerable to the weight gain. It is assumed, that the long drought season might have slightly decreased their original bodyweight, but could not decrease the BMI status to be below 25. Intake of fish and tempe/tofu seemed to give a better contribution for percent-fulfillment of protein intake. The lowest percent-fulfillment was found in iron intake of all women by ±13%, which was confirmed by a high proportion of anemic women in all groups in the study area.

4.2 The influence of climatic factors of food security

From June to November 2015 the Indonesian Agency for Meteorology Climatology and Geophysics forecasted that Indonesia would experience a long drought season accompanied by a thick fog from forest-burn (Indonesian Agency for Meteorology Climatology and Geophysics 2015). The effect of extreme weather has proven to decrease agriculture production in China (Wei et al 2017), Zambia (Lekprichakul 2008), and Indonesia (Lassa 2012; Surmaini et al 2014) causing the farmer families to cope during lean season. Lassa (2012) reported that drought in Indonesia has caused significant reduction in rice paddy and maize production. The effect being more severely when accompanied by flood attack, like in Momunu sub-district. Drought season alone in the country have shown to decrease the rice paddy production by 40% (Surmaini et al 2014). In December 2015 World Food Program (WFP) carried out a survey in four provinces of eastern part of Indonesia (East Java, East Nusa Tenggara, West Nusa Tenggara and Papua) to investigate the drought effect on farmer families (World Food Programme 2016). They found that 40% of rice farmers decreased up to 50% of their rice paddy production. With less income farmer families had to cope by reducing food bought and non-food expenditure, thus relying on their second job or reducing amount, type and frequency of meal. In our study, tree-based crop farmers were found to have the highest proportion of farmers having secondary job (61.8%), followed by mixed-crop farmers (52.7%). Because tree-based crop farmers in the study area basically practiced traditionally or based on demand farming activities, therefore it was likely that time allocated for tree-based farming activities was not as tight as the annual-cropping system, which allowed the tree-based crop farmers to have the second job. The need on purchasing foods was also the other main reasons to generate off-farm income, since they did not produce their own foods. Qualitative study that was done prior to the survey revealed that main crop production had decreased 20-30 percent due to the long drought season in 2015. Therefore, it was likely that the 2015 production (either annual or tree-based crops) was lower than the usual production

Regardless of the groups, the 2015's long drought season existed during the survey period seemed to strongly affect the agriculture, dietary intake, health and nutritional situation of the women and children in the study area. The farmers complained of the decreased crop production, which led to a decrease in income generated from agriculture activities. Wasting prevalence among children from tree-based crop farmer was above the critical WHO value of emergency situation, followed by that from non-farmer group. Infectious diseases were also more prevalent during drought season, which was worsen by the polluted air from forest-burned.

5. Conclusions and the Way Forward

Tree-based crop farmers seemed to suffer more severely due to food insecurity as compared to the other groups. They had the highest proportion of father having second job. They also had the second highest prevalence of respiratory infection among children and the highest prevalence of wasted children above 10% (20.6%) indicating the severe condition of income deprivation and food insecurity within the families. In addition, they did not plant food crops, consequently they had to allocate their income for food expenditure and resulted to a high proportion of poor families (indicated by monthly food expenditure ≥80%). It is recommended to combine cultivation of food and cash crops for reducing the food expenditure. As the study has shown although annual-crop farmers had the lowest median yearly income, the proportion of poor families was lower than tree-based crop farmers. The mix-crop farmers seemed to have a better-off socio-economic condition as compared to the other farmer groups. Non-farmer group seemed to be the second highest in food insecurity after the tree-based crop farmers. This might be because of widely spread income of respondents from a common farm worker to a successful businessman.

In the study, it was revealed that less than 50% of the respondents utilized their garden. We proposed that the utilization of the garden for planting carbohydrate-source of foods (e.g. sweet potatoes) and micronutrient rich-foods (e.g. carrots, tomatoes, different type of coloured fruits) as well as livestock raising for the protein production.

Low dietary intake, high prevalence of underweight and stunting children and anemia prevalence among non-pregnant women indicate the need for nutrition intervention in rehabilitating the nutritional status of women and children in the study area. For the undernourished children and women, it is necessary to rehabilitate their nutritional status by providing supplementary food, combined with a complete package of health/nutrition education targeting the mothers and the other caregivers (e.g. grandmothers). After the women/children have recovered, they should be offered a well-balance home-based meal for maintaining their nutritional status. It is also proposed to develop a women's group for doing sport activity together. Nutrition education regarding portion size and healthy meal for the women needs to be given.

We recommended that the anemic women should be given iron tablets on weekly basis. For maintaining their iron status, the women should be taught to consume iron-rich foods every week, e.g. chicken liver. Commonly consumed foods or drinks that promote and inhibit the iron absorption should be identified as part of the nutrition education.

Since the survey was carried out during a lean season, we propose to carry out a study during harvest season to give a complete picture of the food and nutrition situation in the study area.

References

Awasthi S, Das R, Verma T, Vir S. 2003. Anemia and undernutrition among preschool children in Uttar Pradesh, India. *Indian Pediatrics* 40, 985-990.

Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet* 371, 243-260.

Gibson RS. 2005. *Principles of Nutritional Assessment.* Oxford University Press, Inc, UK.

Harvey C, Rakotobe Z, Rao N, Dave R, Razafimahatratra H, Rabarijohn R, Rajaofara H, MacKinnon J. 2014. Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philosophical Transactions of the Royal Society B*, 369: 20130089.

Headey D, Ecker O. 2013. Rethinking the measurement of food security: from first principles to best practice. *Food Security* 5, 327-343.

Ickowitz A, Rowland D, Powell B, Salim MA, Sunderland T. 2016. *Forests, Trees, and Micronutrient-Rich Food Consumption in Indonesia*. PLOS ONE 11, e0154139.

Ministry of Health Republic of Indonesia. 2013. *Angka kecukupan gizi yang dianjurkan bagi bangsa Indonesia (Indonesian Recommended Dietary Allowance)*. Jakarta, Indonesia: Ministry of Health Republic of Indonesia. Legislative Act of Ministry of Health No 17/2013.

Indonesian Agency for Meteorology Climatology and Geophysics, 2015. Monitoring perkembangan El Nino 2015 dan antipasi dampaknya di Indonesia (*Monitoring developments of 2015 El-Nino and forecasting its impact in Indonesia)*. Ekspose Antisipasi El Nino dan Tingkat Kerawanan Kebakaran Hutan dan Lahan pada Periode Juli s/d Oktober 2015.

Jati IRAP, Vellingiri V, Donatus N, Hans KB. 2012. Dietary formulation to overcome micronutrient deficiency status in Indonesia. *Nutrition & Food Science* 42, 362-370.

Johnston JL, Fanzo JC, Cogill B, 2014. Understanding Sustainable Diets: A Descriptive Analysis of the Determinants and Processes That Influence Diets and Their Impact on Health, Food Security, and Environmental Sustainability. *Advances in Nutrition: An International Review Journal* 5, 418-429.

Khomsan A, Anwar F, Hernawati N, Suhanda N, Warsito O, Herawati T. 2013. Growth, Cognitive Development and Psychosocial Stimulation of Preschool Children in Poor Farmer and Non-Farmer Households. *Malaysian Journal of Nutrition* 19, 325-337.

Lassa JA. 2012. Emerging 'Agricultural Involution' in Indonesia: Impact of Natural Hazards and Climate Extremes on Agricultural Crops and Food System. In: Sawada Y, Oum S, eds. *Economic and Welfare Impacts of Disasters in East Asia and Policy Responses*. ERIA Research Project Report 2011-8. ERIA, Jakarta, pp. 601-640.

Lekprichakul T. 2008. *Impact of 2004/2005 drought on Zambia's agricultural production*. Working Paper on Social-Ecological Resilience Series Research Institute for Humanity and Nature (RIHN), p. 21.

National Intititute of Health Research and Development. 2011. *Indonesian Health Profile 2010 (Riset Kesehatan Dasar)*. Jakarta, Indonesia: Ministry of Health Republic Indonesia. p. 431.

Rahayu S, Lusiana B, Amaruzaman S, Hendrawan DCP, Pambudi S. 2015. *Tree diversity and its use in Buol District, Indonesia*. Working Paper 212. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Sanchez PA, Swaminathan MS. 2005. Cutting World Hunger in Half. *Science* 307, 357-359.

Surmaini E, Hadi TW, Subagyono K, Puspito NT. 2014. Early detection of drought impact on rice paddies in Indonesia by means of Nino 3.4 index. *Theoretical and Applied Climatology* 121, 669-684.

The Economist Intelligence Unit. 2017. The Global Food Security Index 2017: *Measuring food security and the impact of resource risks*. The Global Food Security Index p. 54.

UNICEF. 1998. *The State of the World Children 1998*. New York, USA: United Nations Children's Fund, p. 131.

Victora C, Adair L, Fall C, Hallal P, Martorell R, Richter L, Sachdev H. 2008. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 371, 340-357.

Wei T, Glomsrød S, Zhang T. 2017. Extreme weather, food security and the capacity to adapt – the case of crops in China. *Food Security* 9, 523-535.

WHO. 1995. *Physical status: the use and interpretation of anthropometry: report of a WHO Expert Committee. Geneva*. WHO technical report series. WHO, Geneva.

Wilk MB, Gnanadesikan R. 1968. Probability plotting methods for the analysis for the analysis of data. *Biometrika* 55, 1-17.

World Food Programme. 2016. *Indonesia - The Impact of Drought on Households in Four Provinces in Eastern Indonesia*. World Food Programme Indonesia, p. 86.

World Health Organization. 1995. *Physical status: the use and interpretation of anthropometry: report of a WHO Expert Committee*. WHO Technical Report Series. WHO, Geneva.

WORKING PAPERS WITH DOIs

2005

1. Agroforestry in the drylands of eastern Africa: a call to action
2. Biodiversity conservation through agroforestry: managing tree species diversity within a network of community-based, nongovernmental, governmental and research organizations in western Kenya.
3. Invasion of *prosopis juliflora* and local livelihoods: Case study from the Lake Baringo area of Kenya
4. Leadership for change in farmers organizations: Training report: Ridar Hotel, Kampala, 29th March to 2nd April 2005.
5. Domestication des espèces agroforestières au Sahel : situation actuelle et perspectives
6. Relevé des données de biodiversité ligneuse: Manuel du projet biodiversité des parcs agroforestiers au Sahel
7. Improved land management in the Lake Victoria Basin: TransVic Project's draft report.
8. Livelihood capital, strategies and outcomes in the Taita hills of Kenya
9. Les espèces ligneuses et leurs usages: Les préférences des paysans dans le Cercle de Ségou, au Mali
10. La biodiversité des espèces ligneuses: Diversité arborée et unités de gestion du terroir dans le Cercle de Ségou, au Mali

2006

11. Bird diversity and land use on the slopes of Mt. Kilimanjaro and the adjacent plains, Tanzania
12. Water, women and local social organization in the Western Kenya Highlands
13. Highlights of ongoing research of the World Agroforestry Centre in Indonesia
14. Prospects of adoption of tree-based systems in a rural landscape and its likely impacts on carbon stocks and farmers' welfare: The FALLOW Model Application in Muara Sungkai, Lampung, Sumatra, in a 'Clean Development Mechanism' context
15. Equipping integrated natural resource managers for healthy Agroforestry landscapes.
17. Agro-biodiversity and CGIAR tree and forest science: approaches and examples from Sumatra.
18. Improving land management in eastern and southern Africa: A review of policies.
19. Farm and household economic study of Kecamatan Nanggung, Kabupaten Bogor, Indonesia: A socio-economic base line study of Agroforestry innovations and livelihood enhancement.
20. Lessons from eastern Africa's unsustainable charcoal business.
21. Evolution of RELMA's approaches to land management: Lessons from two decades of research and development in eastern and southern Africa
22. Participatory watershed management: Lessons from RELMA's work with farmers in eastern Africa.
23. Strengthening farmers' organizations: The experience of RELMA and ULAMP.
24. Promoting rainwater harvesting in eastern and southern Africa.
25. The role of livestock in integrated land management.
26. Status of carbon sequestration projects in Africa: Potential benefits and challenges to scaling up.

27. Social and Environmental Trade-Offs in Tree Species Selection: A Methodology for Identifying Niche Incompatibilities in Agroforestry *[Appears as AHI Working Paper no. 9]*

28. Managing tradeoffs in agroforestry: From conflict to collaboration in natural resource management. *[Appears as AHI Working Paper no. 10]*
29. Essai d'analyse de la prise en compte des systemes agroforestiers pa les legislations forestieres au Sahel: Cas du Burkina Faso, du Mali, du Niger et du Senegal.
30. Etat de la recherche agroforestière au Rwanda etude bibliographique, période 1987-2003

2007

31. Science and technological innovations for improving soil fertility and management in Africa: A report for NEPAD's Science and Technology Forum.
32. Compensation and rewards for environmental services.
33. Latin American regional workshop report compensation.
34. Asia regional workshop on compensation ecosystem services.
35. Report of African regional workshop on compensation ecosystem services.
36. Exploring the inter-linkages among and between compensation and rewards for ecosystem services CRES and human well-being
37. Criteria and indicators for environmental service compensation and reward mechanisms: realistic, voluntary, conditional and pro-poor
38. The conditions for effective mechanisms of compensation and rewards for environmental services.
39. Organization and governance for fostering Pro-Poor Compensation for Environmental Services.
40. How important are different types of compensation and reward mechanisms shaping poverty and ecosystem services across Africa, Asia & Latin America over the Next two decades?
41. Risk mitigation in contract farming: The case of poultry, cotton, woodfuel and cereals in East Africa.
42. The RELMA savings and credit experiences: Sowing the seed of sustainability
43. Yatich J., Policy and institutional context for NRM in Kenya: Challenges and opportunities for Landcare.
44. Nina-Nina Adoung Nasional di So! Field test of rapid land tenure assessment (RATA) in the Batang Toru Watershed, North Sumatera.
45. Is Hutan Tanaman Rakyat a new paradigm in community based tree planting in Indonesia?
46. Socio-Economic aspects of brackish water aquaculture (*Tambak*) production in Nanggroe Aceh Darrusalam.
47. Farmer livelihoods in the humid forest and moist savannah zones of Cameroon.
48. Domestication, genre et vulnérabilité : Participation des femmes, des Jeunes et des catégories les plus pauvres à la domestication des arbres agroforestiers au Cameroun.
49. Land tenure and management in the districts around Mt Elgon: An assessment presented to the Mt Elgon ecosystem conservation programme.
50. The production and marketing of leaf meal from fodder shrubs in Tanga, Tanzania: A pro-poor enterprise for improving livestock productivity.
51. Buyers Perspective on Environmental Services (ES) and Commoditization as an approach to liberate ES markets in the Philippines.

52. Towards Towards community-driven conservation in southwest China: Reconciling state and local perceptions.
53. Biofuels in China: An Analysis of the Opportunities and Challenges of Jatropha curcas in Southwest China.
54. Jatropha curcas biodiesel production in Kenya: Economics and potential value chain development for smallholder farmers
55. Livelihoods and Forest Resources in Aceh and Nias for a Sustainable Forest Resource Management and Economic Progress
56. Agroforestry on the interface of Orangutan Conservation and Sustainable Livelihoods in Batang Toru, North Sumatra.

2008

57. Assessing Hydrological Situation of Kapuas Hulu Basin, Kapuas Hulu Regency, West Kalimantan.
58. Assessing the Hydrological Situation of Talau Watershed, Belu Regency, East Nusa Tenggara.
59. Kajian Kondisi Hidrologis DAS Talau, Kabupaten Belu, Nusa Tenggara Timur.
60. Kajian Kondisi Hidrologis DAS Kapuas Hulu, Kabupaten Kapuas Hulu, Kalimantan Barat.
61. Lessons learned from community capacity building activities to support agroforest as sustainable economic alternatives in Batang Toru orang utan habitat conservation program (Martini, Endri et al.)
62. Mainstreaming Climate Change in the Philippines.
63. A Conjoint Analysis of Farmer Preferences for Community Forestry Contracts in the Sumber Jaya Watershed, Indonesia.
64. The highlands: a shared water tower in a changing climate and changing Asia
65. Eco-Certification: Can It Deliver Conservation and Development in the Tropics.
66. Designing ecological and biodiversity sampling strategies. Towards mainstreaming climate change in grassland management.
67. Towards mainstreaming climate change in grassland management policies and practices on the Tibetan Plateau
68. An Assessment of the Potential for Carbon Finance in Rangelands
69 ECA Trade-offs Among Ecosystem Services in the Lake Victoria Basin.
69. The last remnants of mega biodiversity in West Java and Banten: an in-depth exploration of RaTA (Rapid Land Tenure Assessment) in Mount Halimun-Salak National Park Indonesia
70. Le business plan d'une petite entreprise rurale de production et de commercialisation des plants des arbres locaux. Cas de quatre pépinières rurales au Cameroun.
71. Les unités de transformation des produits forestiers non ligneux alimentaires au Cameroun. Diagnostic technique et stratégie de développement Honoré Tabuna et Ingratia Kayitavu.
72. Les exportateurs camerounais de safou (Dacryodes edulis) sur le marché sous régional et international. Profil, fonctionnement et stratégies de développement.
73. Impact of the Southeast Asian Network for Agroforestry Education (SEANAFE) on agroforestry education capacity.
74. Setting landscape conservation targets and promoting them through compatible land use in the Philippines.
75. Review of methods for researching multistrata systems.

76. Study on economical viability of *Jatropha curcas* L. plantations in Northern Tanzania assessing farmers' prospects via cost-benefit analysis
77. Cooperation in Agroforestry between Ministry of Forestry of Indonesia and International Center for Research in Agroforestry
78. "China's bioenergy future. an analysis through the Lens if Yunnan Province
79. Land tenure and agricultural productivity in Africa: A comparative analysis of the economics literature and recent policy strategies and reforms
80. Boundary organizations, objects and agents: linking knowledge with action in Agroforestry watersheds
81. Reducing emissions from deforestation and forest degradation (REDD) in Indonesia: options and challenges for fair and efficient payment distribution mechanisms

2009

82. Mainstreaming climate change into agricultural education: challenges and perspectives
83. Challenging conventional mindsets and disconnects in conservation: the emerging role of eco-agriculture in Kenya's landscape mosaics
84. Lesson learned RATA garut dan bengkunat: suatu upaya membedah kebijakan pelepasan kawasan hutan dan redistribusi tanah bekas kawasan hutan
85. The emergence of forest land redistribution in Indonesia
86. Commercial opportunities for fruit in Malawi
87. Status of fruit production processing and marketing in Malawi
88. Fraud in tree science
89. Trees on farm: analysis of global extent and geographical patterns of agroforestry
90. The springs of Nyando: water, social organization and livelihoods in Western Kenya
91. Building capacity toward region-wide curriculum and teaching materials development in agroforestry education in Southeast Asia
92. Overview of biomass energy technology in rural Yunnan (Chinese – English abstract)
93. A pro-growth pathway for reducing net GHG emissions in China
94. Analysis of local livelihoods from past to present in the central Kalimantan Ex-Mega Rice Project area
95. Constraints and options to enhancing production of high quality feeds in dairy production in Kenya, Uganda and Rwanda

2010

96. Agroforestry education in the Philippines: status report from the Southeast Asian Network for Agroforestry Education (SEANAFE)
97. Economic viability of Jatropha curcas L. plantations in Northern Tanzania- assessing farmers' prospects via cost-benefit analysis.
98. Hot spot of emission and confusion: land tenure insecurity, contested policies and competing claims in the central Kalimantan Ex-Mega Rice Project area
99. Agroforestry competences and human resources needs in the Philippines
100. CES/COS/CIS paradigms for compensation and rewards to enhance environmental Services

101. Case study approach to region-wide curriculum and teaching materials development in agroforestry education in Southeast Asia
102. Stewardship agreement to reduce emissions from deforestation and degradation (REDD): Lubuk Beringin's Hutan Desa as the first village forest in Indonesia
103. Landscape dynamics over time and space from ecological perspective
104. Komoditisasi atau koinvestasi jasa lingkungan: skema imbal jasa lingkungan program peduli sungai di DAS Way Besai, Lampung, Indonesia
105. Improving smallholders' rubber quality in Lubuk Beringin, Bungo district, Jambi province, Indonesia: an initial analysis of the financial and social benefits
106. Rapid Carbon Stock Appraisal (RACSA) in Kalahan, Nueva Vizcaya, Philippines
107. Tree domestication by ICRAF and partners in the Peruvian Amazon: lessons learned and future prospects in the domain of the Amazon Initiative eco-regional program
108. Memorias del Taller Nacional: "Iniciativas para Reducir la Deforestación en la region Andino - Amazónica", 09 de Abril del 2010. Proyecto REALU Peru
109. Percepciones sobre la Equidad y Eficiencia en la cadena de valor de REDD en Perú –Reporte de Talleres en Ucayali, San Martín y Loreto, 2009. Proyecto REALU-Perú.
110. Reducción de emisiones de todos los Usos del Suelo. Reporte del Proyecto REALU Perú Fase 1
111. Programa Alternativas a la Tumba-y-Quema (ASB) en el Perú. Informe Resumen y Síntesis de la Fase II. 2da. versión revisada
112. Estudio de las cadenas de abastecimiento de germoplasma forestal en la amazonía Boliviana
113. Biodiesel in the Amazon
114. Estudio de mercado de semillas forestales en la amazonía Colombiana
115. Estudio de las cadenas de abastecimiento de germoplasma forestal en Ecuador http://dx.doi.org10.5716/WP10340.PDF
116. How can systems thinking, social capital and social network analysis help programs achieve impact at scale?
117. Energy policies, forests and local communities in the Ucayali Region, Peruvian Amazon
118. NTFPs as a Source of Livelihood Diversification for Local Communities in the Batang Toru Orangutan Conservation Program
119. Studi Biodiversitas: Apakah agroforestry mampu mengkonservasi keanekaragaman hayati di DAS Konto?
120. Estimasi Karbon Tersimpan di Lahan-lahan Pertanian di DAS Konto, Jawa Timur
121. Implementasi Kaji Cepat Hidrologi (RHA) di Hulu DAS Brantas, Jawa Timur. http://dx.doi.org/10.5716/WP10338.PDF
122. Kaji Cepat Hidrologi di Daerah Aliran Sungai Krueng Peusangan, NAD,Sumatra http://dx.doi.org/10.5716/WP10337.PDF
123. A Study of Rapid Hydrological Appraisal in the Krueng Peusangan Watershed, NAD, Sumatra. http://dx.doi.org/10.5716/WP10339.PDF

2011

124. An Assessment of farm timber value chains in Mt Kenya area, Kenya
125. A Comparative financial analysis of current land use systems and implications for the adoption of improved agroforestry in the East Usambaras, Tanzania
126. Agricultural monitoring and evaluation systems

127. Challenges and opportunities for collaborative landscape governance in the East Usambara Mountains, Tanzania
128. Transforming Knowledge to Enhance Integrated Natural Resource Management Research, Development and Advocacy in the Highlands of Eastern Africa http://dx.doi.org/10.5716/WP11084.PDF
129. Carbon-forestry projects in the Philippines: potential and challenges The Mt Kitanglad Range forest-carbon development http://dx.doi.org10.5716/WP11054.PDF
130. Carbon forestry projects in the Philippines: potential and challenges. The Arakan Forest Corridor forest-carbon project. http://dx.doi.org10.5716/WP11055.PDF
131. Carbon-forestry projects in the Philippines: potential and challenges. The Laguna Lake Development Authority's forest-carbon development project. http://dx.doi.org/10.5716/WP11056.PDF
132. Carbon-forestry projects in the Philippines: potential and challenges. The Quirino forest-carbon development project in Sierra Madre Biodiversity Corridor http://dx.doi.org10.5716/WP11057.PDF
133. Carbon-forestry projects in the Philippines: potential and challenges. The Ikalahan Ancestral Domain forest-carbon development http://dx.doi.org10.5716/WP11058.PDF
134. The Importance of Local Traditional Institutions in the Management of Natural Resources in the Highlands of Eastern Africa. http://dx.doi.org/10.5716/WP11085.PDF
135. Socio-economic assessment of irrigation pilot projects in Rwanda. http://dx.doi.org/10.5716/WP11086.PDF
136. Performance of three rambutan varieties *(Nephelium lappaceum* L.*)* on various nursery media. http://dx.doi.org/10.5716/WP11232.PDF
137. Climate change adaptation and social protection in agroforestry systems: enhancing adaptive capacity and minimizing risk of drought in Zambia and Honduras http://dx.doi.org/10.5716/WP11269.PDF
138. Does value chain development contribute to rural poverty reduction? Evidence of asset building by smallholder coffee producers in Nicaragua http://dx.doi.org/10.5716/WP11271.PDF
139. Potential for biofuel feedstock in Kenya. http://dx.doi.org/10.5716/WP11272.PDF
140. Impact of fertilizer trees on maize production and food security in six districts of Malawi. http://dx.doi.org/10.5716/WP11281.PDF

2012

141. Fortalecimiento de capacidades para la gestión del Santuario Nacional Pampa Hermosa: Construyendo las bases para un manejo adaptativo para el desarrollo local. Memorias del Proyecto. http://dx.doi.org/10.5716/WP12005.PDF
142. Understanding rural institutional strengthening: A cross-level policy and institutional framework for sustainable development in Kenya http://dx.doi.org/10.5716/WP12012.PDF
143. Climate change vulnerability of agroforestry http://dx.doi.org/10.5716/WP16722.PDF
144. Rapid assesment of the inner Niger delta of Mali http://dx.doi.org/10.5716/WP12021.PDF
145. Designing an incentive program to reduce on-farm deforestationin the East Usambara Mountains, Tanzania http://dx.doi.org/10.5716/WP12048.PDF
146. Extent of adoption of conservation agriculture and agroforestry in Africa: the case of Tanzania, Kenya, Ghana, and Zambia http://dx.doi.org/10.5716/WP12049.PDF

147. Policy incentives for scaling up conservation agriculture with trees in Africa: the case of Tanzania, Kenya, Ghana and Zambia http://dx.doi.org/10.5716/WP12050.PDF
148. Commoditized or co-invested environmental services? Rewards for environmental services scheme: River Care program Way Besai watershed, Lampung, Indonesia. http://dx.doi.org/10.5716/WP12051.PDF
149. Assessment of the headwaters of the Blue Nile in Ethiopia. http://dx.doi.org/10.5716/WP12160.PDF
150. Assessment of the uThukela Watershed, Kwazaulu. http://dx.doi.org/10.5716/WP12161.PDF
151. Assessment of the Oum Zessar Watershed of Tunisia. http://dx.doi.org/10.5716/WP12162.PDF
152. Assessment of the Ruwenzori Mountains in Uganda. http://dx.doi.org/10.5716/WP12163.PDF
153. History of agroforestry research and development in Viet Nam. Analysis of research opportunities and gaps. http://dx.doi.org/10.5716/WP12052.PDF
154. REDD+ in Indonesia: a Historical Perspective. http://dx.doi.org/10.5716/WP12053.PDF
155. Agroforestry and Forestry in Sulawesi series: Livelihood strategies and land use system dynamics in South Sulawesi http://dx.doi.org/10.5716/WP12054.PDF
156. Agroforestry and Forestry in Sulawesi series: Livelihood strategies and land use system dynamics in Southeast Sulawesi. http://dx.doi.org/10.5716/WP12055.PDF
157. Agroforestry and Forestry in Sulawesi series: Profitability and land-use systems in South and Southeast Sulawesi. http://dx.doi.org/10.5716/WP12056.PDF
158. Agroforestry and Forestry in Sulawesi series: Gender, livelihoods and land in South and Southeast Sulawesi http://dx.doi.org/10.5716/WP12057.PDF
159. Agroforestry and Forestry in Sulawesi series: Agroforestry extension needs at the community level in AgFor project sites in South and Southeast Sulawesi, Indonesia. http://dx.doi.org/10.5716/WP12058.PDF
160. Agroforestry and Forestry in Sulawesi series: Rapid market appraisal of agricultural, plantation and forestry commodities in South and Southeast Sulawesi. http://dx.doi.org/10.5716/WP12059.PDF

2013

161. Diagnosis of farming systems in the Agroforestry for Livelihoods of Smallholder farmers in Northwestern Viet Nam project http://dx.doi.org/10.5716/WP13033.PDF
162. Ecosystem vulnerability to climate change: a literature review. http://dx.doi.org/10.5716/WP13034.PDF
163. Local capacity for implementing payments for environmental services schemes: lessons from the RUPES project in northeastern Viet Nam http://dx.doi.org/10.5716/WP13046.PDF
164. Seri Agroforestri dan Kehutanan di Sulawesi: Agroforestry dan Kehutanan di Sulawesi: Strategi mata pencaharian dan dinamika sistem penggunaan lahan di Sulawesi Selatan http://dx.doi.org/10.5716/WP13040.PDF
165. Seri Agroforestri dan Kehutanan di Sulawesi: Mata pencaharian dan dinamika sistem penggunaan lahan di Sulawesi Tenggara http://dx.doi.org/10.5716/WP13041.PDF
166. Seri Agroforestri dan Kehutanan di Sulawesi: Profitabilitas sistem penggunaan lahan di Sulawesi Selatan dan Sulawesi Tenggara http://dx.doi.org/10.5716/WP13042.PDF
167. Seri Agroforestri dan Kehutanan di Sulawesi: Gender, mata pencarian dan lahan di Sulawesi Selatan dan Sulawesi Tenggara http://dx.doi.org/10.5716/WP13043.PDF

168. Seri Agroforestri dan Kehutanan di Sulawesi: Kebutuhan penyuluhan agroforestri pada tingkat masyarakat di lokasi proyek AgFor di Sulawesi Selatan dan Tenggara, Indonesia. http://dx.doi.org/10.5716/WP13044.PDF
169. Seri Agroforestri dan Kehutanan di Sulawesi: Laporan hasil penilaian cepat untuk komoditas pertanian, perkebunan dan kehutanan di Sulawesi Selatan dan Tenggara http://dx.doi.org/10.5716/WP13045.PDF
170. Agroforestry, food and nutritional security http://dx.doi.org/10.5716/WP13054.PDF
171. Stakeholder Preferences over Rewards for Ecosystem Services: Implications for a REDD+ Benefit Distribution System in Viet Nam http://dx.doi.org/10.5716/WP13057.PDF
172. Payments for ecosystem services schemes: project-level insights on benefits for ecosystems and the rural poor http://dx.doi.org/10.5716/WP13001.PDF
173. Good practices for smallholder teak plantations: keys to success http://dx.doi.org/10.5716/WP13246.PDF
174. Market analysis of selected agroforestry products in the Vision for Change Project intervention Zone, Côte d'Ivoire http://dx.doi.org/10.5716/WP13249.PDF
175. Rattan futures in Katingan: why do smallholders abandon or keep their gardens in Indonesia's 'rattan district'? http://dx.doi.org/10.5716/WP13251.PDF
176. Management along a gradient: the case of Southeast Sulawesi's cacao production landscapes http://dx.doi.org/10.5716/WP13265.PDF

2014

177. Are trees buffering ecosystems and livelihoods in agricultural landscapes of the Lower Mekong Basin? Consequences for climate-change adaptation. http://dx.doi.org/10.5716/WP14047.PDF
178. Agroforestry, livestock, fodder production and climate change adaptation and mitigation in East Africa: issues and options. http://dx.doi.org/10.5716/WP14050.PDF
179. Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics. http://dx.doi.org/10.5716/WP14064.PDF
180. Beyond reforestation: an assessment of Vietnam's REDD+ readiness. http://dx.doi.org/10.5716/WP14097.PDF
181. Farmer-to-farmer extension in Kenya: the perspectives of organizations using the approach. http://dx.doi.org/10.5716/WP14380.PDF
182. Farmer-to-farmer extension in Cameroon: a survey of extension organizations. http://dx.doi.org/10.5716/WP14383.PDF
183. Farmer-to-farmer extension approach in Malawi: a survey of organizations: a survey of organizations http://dx.doi.org/10.5716/WP14391.PDF
184. Seri Agroforestri dan Kehutanan di Sulawesi: Kuantifikasi jasa lingkungan air dan karbon pola agroforestri pada hutan rakyat di wilayah sungai Jeneberang
185. Options for Climate-Smart Agriculture at Kaptumo Site in Kenyahttp://dx.doi.org/10.5716/WP14394.PDF

2015

186. Agroforestry for Landscape Restoration and Livelihood Development in Central Asia http://dx.doi.org/10.5716/WP14143.PDF

187. "Projected Climate Change and Impact on Bioclimatic Conditions in the Central and South-Central Asia Region" http://dx.doi.org/10.5716/WP14144.PDF
188. Land Cover Changes, Forest Loss and Degradation in Kutai Barat, Indonesia. http://dx.doi.org/10.5716/WP14145.PDF
189. The Farmer-to-Farmer Extension Approach in Malawi: A Survey of Lead Farmers. http://dx.doi.org/10.5716/WP14152.PDF
190. Evaluating indicators of land degradation and targeting agroforestry interventions in smallholder farming systems in Ethiopia. http://dx.doi.org/10.5716/WP14252.PDF
191. Land health surveillance for identifying land constraints and targeting land management options in smallholder farming systems in Western Cameroon
192. Land health surveillance in four agroecologies in Malawi
193. Cocoa Land Health Surveillance: an evidence-based approach to sustainable management of cocoa landscapes in the Nawa region, South-West Côte d'Ivoire http://dx.doi.org/10.5716/WP14255.PDF
194. Situational analysis report: Xishuangbanna autonomous Dai Prefecture, Yunnan Province, China. http://dx.doi.org/10.5716/WP14255.PDF
195. Farmer-to-farmer extension: a survey of lead farmers in Cameroon. http://dx.doi.org/10.5716/WP15009.PDF
196. From transition fuel to viable energy source Improving sustainability in the sub-Saharan charcoal sector http://dx.doi.org/10.5716/WP15011.PDF
197. Mobilizing Hybrid Knowledge for More Effective Water Governance in the Asian Highlands http://dx.doi.org/10.5716/WP15012.PDF
198. Water Governance in the Asian Highlands http://dx.doi.org/10.5716/WP15013.PDF
199. Assessing the Effectiveness of the Volunteer Farmer Trainer Approach in Dissemination of Livestock Feed Technologies in Kenya vis-à-vis other Information Sources http://dx.doi.org/10.5716/WP15022.PDF
200. The rooted pedon in a dynamic multifunctional landscape: Soil science at the World Agroforestry Centre http://dx.doi.org/10.5716/WP15023.PDF
201. Characterising agro-ecological zones with local knowledge. Case study: Huong Khe district, Ha Tinh, Viet Nam http://dx.doi.org/10.5716/WP15050.PDF
202. Looking back to look ahead: Insight into the effectiveness and efficiency of selected advisory approaches in the dissemination of agricultural technologies indicative of Conservation Agriculture with Trees in Machakos County, Kenya. http://dx.doi.org/10.5716/WP15065.PDF
203. Pro-poor Biocarbon Projects in Eastern Africa Economic and Institutional Lessons. http://dx.doi.org/10.5716/WP15022.PDF
204. Projected climate change impacts on climatic suitability and geographical distribution of banana and coffee plantations in Nepal. http://dx.doi.org/10.5716/WP15294.PDF
205. Agroforestry and Forestry in Sulawesi series: Smallholders' coffee production and marketing in Indonesia. A case study of two villages in South Sulawesi Province. http://dx.doi.org/10.5716/WP15690.PDF
206. Mobile phone ownership and use of short message service by farmer trainers: a case study of Olkalou and Kaptumo in Kenya http://dx.doi.org/10.5716/WP15691.PDF
207. Associating multivariate climatic descriptors with cereal yields: a case study of Southern Burkina Faso http://dx.doi.org/10.5716/WP15273.PDF
208. Preferences and adoption of livestock feed practices among farmers in dairy management groups in Kenya http://dx.doi.org/10.5716/WP15675.PDF

209. Scaling up climate-smart agriculture: lessons learned from South Asia and pathways for success http://dx.doi.org/10.5716/WP15720.PDF
210. Agroforestry and Forestry in Sulawesi series: Local perceptions of forest ecosystem services and collaborative formulation of reward mechanisms in South and Southeast Sulawesi http://dx.doi.org/10.5716/WP15721.PDF
211. Potential and challenges in implementing the co-investment of ecosystem services scheme in Buol District, Indonesia. http://dx.doi.org/10.5716/WP15722.PDF
212. Tree diversity and its utilization by the local community in Buol District, Indonesia http://dx.doi.org/10.5716/WP15723.PDF
213 Vulnerability of smallholder farmers and their preferences on farming practices in Buol District, Indonesia http://dx.doi.org/10.5716/WP15724.PDF
214. Dynamics of Land Use/Cover Change and Carbon Emission in Buol District, Indonesia http://dx.doi.org/10.5716/WP15725.PDF
215. Gender perspective in smallholder farming practices in Lantapan, Phillippines. http://dx.doi.org/10.5716/WP15726.PDF
216. Vulnerability of smallholder farmers in Lantapan, Bukidnon. http://dx.doi.org/10.5716/WP15727.PDF
217. Vulnerability and adaptive capacity of smallholder farmers in Ho Ho Sub-watershed, Ha Tinh Province, Vietnam http://dx.doi.org/10.5716/WP15728.PDF
218. Local Knowledge on the role of trees to enhance livelihoods and ecosystem services in northern central Vietnam http://dx.doi.org/10.5716/WP15729.PDF
219. Land-use/cover change in Ho Ho Sub-watershed, Ha Tinh Province, Vietnam. http://dx.doi.org/10.5716/WP15730.PDF

2016

220. Agroforestry and Forestry in Sulawesi series: Evaluation of the Agroforestry Farmer Field Schools on agroforestry management in South and Southeast Sulawesi, Indonesia. http://dx.doi.org/10.5716/WP16002.PDF
221. Farmer-to-farmer extension of livestock feed technologies in Rwanda: A survey of volunteer farmer trainers and organizations. http://dx.doi.org/10.5716/WP16005.PDF
222. Projected Climate Change Impact on Hydrology, Bioclimatic Conditions, and Terrestrial Ecosystems in the Asian Highlands http://dx.doi.org/10.5716/WP16006.PDF
223. Adoption of Agroforestry and its impact on household food security among farmers in Malawi http://dx.doi.org/10.5716/WP16013.PDF
224. Agroforestry and Forestry in Sulawesi series: Information channels for disseminating innovative agroforestry practices to villages in Southern Sulawesi, Indonesia http://dx.doi.org/10.5716/WP16034.PDF
225. Agroforestry and Forestry in Sulawesi series: Unravelling rural migration networks.Land-tenure arrangements among Bugis migrant communities in Southeast Sulawesi. http://dx.doi.org/10.5716/WP16035.PDF
226. Agroforestry and Forestry in Sulawesi series: Women's participation in agroforestry: more benefit or burden? A gendered analysis of Gorontalo Province. http://dx.doi.org/10.5716/WP16036.PDF
227. Kajian Kelayakan dan Pengembangan Desain Teknis Rehabilitasi Pesisir di Sulawesi Tengah. http://dx.doi.org/10.5716/WP16037.PDF
228. Selection of son tra clones in North West Vietnam. http://dx.doi.org/10.5716/WP16038.PDF

229. Growth and fruit yield of seedlings, cuttings and grafts from selected son tra trees in Northwest Vietnam http://dx.doi.org/10.5716/WP16046.PDF
230. Gender-Focused Analysis of Poverty and Vulnerability in Yunnan, China http://dx.doi.org/10.5716/WP16071.PDF
231. Seri Agroforestri dan Kehutanan di Sulawesi: Kebutuhan Penyuluhan Agroforestri untuk Rehabilitasi Lahan di Sumba Timur, Nusa Tenggara Timur, Indonesia. http://dx.doi.org/10.5716/WP16077.PDF
232. Agroforestry and Forestry in Sulawesi series: Agroforestry extension needs for land rehabilitation in East Sumba, East Nusa Tenggara, Indonesia. http://dx.doi.org/10.5716/WP16078.PDF
233. Central hypotheses for the third agroforestry paradigm within a common definition. http://dx.doi.org/10.5716/WP16079.PDF
234. Assessing smallholder farmers' interest in shade coffee trees: The Farming Systems of Smallholder Coffee Producers in the Gisenyi Area, Rwanda: a participatory diagnostic study. http://dx.doi.org/10.5716/WP16104.PDF
235. Review of agricultural market information systems in |sub-Saharan Africa. http://dx.doi.org/10.5716/WP16110.PDF
236. Vision and road map for establishment of a protected area in Lag Badana, Lower Jubba, Somalia. http://dx.doi.org/10.5716/WP16127.PDF
237. Replicable tools and frameworks for Bio-Carbon Development in West Africa. http://dx.doi.org/10.5716/WP16138.PDF
238. Existing Conditions, Challenges and Needs in the Implementation of Forestry and Agroforestry Extension in Indonesia. http://dx.doi.org/10.5716/WP16141.PDF
239. Situasi Terkini, Tantangan dan Kebutuhan Pelaksanaan Penyuluhan Kehutanan dan Agroforestri di Indonesia. http://dx.doi.org/10.5716/WP16142.PDF
240. The national agroforestry policy of India: experiential learning in development and delivery phases. http://dx.doi.org/10.5716/WP16143.PDF
241. Agroforestry and Forestry in Sulawesi series: Livelihood strategies and land-use system dynamics in Gorontalo. http://dx.doi.org/10.5716/WP16157.PDF
242. Seri Agroforestri dan Kehutanan di Sulawesi: Strategi mata pencaharian dan dinamika sistem penggunaan lahan di Gorontalo. http://dx.doi.org/10.5716/WP16158.PDF
243. Ruang, Gender dan Kualitas Hidup Manusia: Sebuah studi Gender pada komunitas perantau dan pengelola kebun di Jawa Barat. http://dx.doi.org/10.5716/WP16159.PDF
244. Gendered Knowledge and perception in managing grassland areas in East Sumba, Indonesia. http://dx.doi.org/10.5716/WP16160.PDF
245. Pengetahuan dan persepsi masyarakat pengelola padang aavana, Sebuah Kajian Gender di Sumba Timur. http://dx.doi.org/10.5716/WP16161.PDF
246. Dinamika Pengambilan Keputusan pada komunitas perantau dan pengelola kebun di Jawa Barat. http://dx.doi.org/10.5716/WP16162.PDF
247. Gaharu (eaglewood) domestication: Biotechnology, markets and agroforestry options. http://dx.doi.org/10.5716/WP16163.PDF
248. Marine habitats of the Lamu-Kiunga coast: an assessment of biodiversity value, threats and opportunities. http://dx.doi.org/10.5716/WP16167.PDF
249. Assessment of the biodiversity in terrestrial landscapes of the Witu protected area and surroundings, Lamu County Kenya. http://dx.doi.org/10.5716/WP16172.PDF
250. An ecosystem services perspective on benefits that people derive from biodiversity of Coastal forests in Lamu County, Kenya http://dx.doi.org/10.5716/WP16173.PDF

251. Assessment of the biodiversity in terrestrial and marine landscapes of the proposed Laga Badana National Park and surrounding areas, Jubaland, Somalia. http://dx.doi.org/10.5716/WP16174.PDF

2017

252. Preferensi Petani terhadap Topik Penyuluhan dan Penyebaran Informasi Agroforestri di Indonesia. http://dx.doi.org/10.5716/WP16181.PDF
253. Seri Agroforestri dan Kehutanan di Sulawesi: Keanekaragaman hayati jenis pohon pada hutan rakyat agroforestri di DAS Balangtieng, Sulawesi Selatan. http://dx.doi.org/10.5716/WP16182.PDF
254. Potensi dan Tantangan dalam Pengembangan Skema Ko-Investasi Jasa Lingkungan di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17008.PDF
255. Keragaman Jenis Pohon dan Pemanfaatannya oleh Masyarakat di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17009.PDF
256. Kerentanan dan preferensi sistem pertanian petani di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17010.PDF
257. Dinamika Perubahan Penggunaan/Tutupan Lahan Serta Cadangan Karbon di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17011.PDF
258. The Effectiveness of the Volunteer Farmer Trainer Approach vis-à-vis Other Information Sources in Dissemination of Livestock Feed Technologies in Uganda. http://dx.doi.org/10.5716/WP17104.PDF
259. Agroforestry and Forestry in Sulawesi series: Impact of agricultural-extension booklets on community livelihoods in South and Southeast Sulawesi. http://dx.doi.org/10.5716/WP17125.PDF
260. Petani Menjadi Penyuluh, Mungkinkah? Sebuah Pendekatan Penyuluhan dari Petani ke Petani di Kabupaten Sumba Timur. http://dx.doi.org/10.5716/WP17145.PDF
261. Dampak Perubahan Tutupan Lahan terhadap Kondisi Hidrologi di Das Buol, Kabupaten Buol, Sulawesi Tengah: Simulasi dengan Model Genriver. http://dx.doi.org/10.5716/WP17146.PDF
262. Analisis Tapak Mata Air Umbulan, Pasuruan, Jawa Timur. Kajian elemen biofisik dan persepsi masyarakat. http://dx.doi.org/10.5716/WP17147.PDF
263. Planned comparisons demystified. http://dx.doi.org/10.5716/WP17354.PDF
264. Soil health decision support for NERC digital soil platforms: A survey report. http://dx.doi.org/10.5716/WP17355.PDF
265. Seri Pembangunan Ekonomi Pedesaan Indonesia: Menanam di bukit gundul: Pengetahuan masyarakat lokal dalam upaya restorasi lahan di Sumba Timur. http://dx.doi.org/10.5716/WP17356.PDF
266. Tree diversity and carbon stock in three districts of Kutai Timur, Pasir and Berau, East Kalimantan http://dx.doi.org/10.5716/WP17357.PDF
267. Tree Diversity and Carbon Stock in Various Land Use Systems of Banyuasin and Musi Banyuasin Districts, South Sumatera http://dx.doi.org/10.5716/WP17358.PDF
268. Tree diversity and carbon stock in various land cover systems of Jayapura, Jayawijaya and Merauke Districts, Papua Province http://dx.doi.org/10.5716/WP17359.PDF
269. Modelling tree production based on farmers' knowledge: case for kapok (*Ceiba pentandra*) and candlenut (Aleurites mollucana) under various agroforestry scenarios. http://dx.doi.org/10.5716/WP17361.PDF

270. The Impact of Land Cover and Climate Change on Present and Future Watershed Condition. Study case: Tugasan, Alanib and Kulasihan Sub-watershed of Manupali Watershed, Lantapan, Bukidnon, Philippines. http://dx.doi.org/10.5716/WP17362.PDF
271. Tree Diversity and Above-ground Carbon Stock estimation in Various Land use Systems in Banjarnegara, Banyumas and Purbalingga, Central Java. http://dx.doi.org/10.5716/WP17363.PDF
272. Agroforestry and Forestry in Sulawesi series: Landscape Management Strategies in Sulawesi: Review of Intervention Options. http://dx.doi.org/10.5716/WP17364.PDF
273. Household Food-Security and Nutritional Status of Women and Children in Buol Regency, Central Sulawesi, Indonesia. http://dx.doi.org/10.5716/WP17365.PDF

The World Agroforestry Centre is an autonomous, non-profit research organization whose vision is a rural transformation in the developing world as smallholder households increase their use of trees in agricultural landscapes to improve food security, nutrition, income, health, shelter, social cohesion, energy resources and environmental sustainability. The Centre generates science-based knowledge about the diverse roles that trees play in agricultural landscapes, and uses its research to advance policies and practices, and their implementation that benefit the poor and the environment. It aims to ensure that all this is achieved by enhancing the quality of its science work, increasing operational efficiency, building and maintaining strong partnerships, accelerating the use and impact of its research, and promoting greater cohesion, interdependence and alignment within the organization.

United Nations Avenue, Gigiri • PO Box 30677 • Nairobi, 00100 • Kenya
Telephone: +254 20 7224000 or via USA +1 650 833 6645
Fax: +254 20 7224001 or via USA +1 650 833 6646
Email: worldagroforestry@cgiar.org • www.worldagroforestry.org

Southeast Asia Regional Program • Sindang Barang • Bogor 16680
PO Box 161 • Bogor 16001 • Indonesia
Telephone: +62 251 8625415 • Fax: +62 251 8625416
• Email: icraf-indonesia@cgiar.org
www.worldagroforestry.org/region/southeast-asia
blog.worldagroforestry.org