SOCA: Jurnal Sosial Ekonomi Pertanian
Vol. 15, No. 1, January 2021, page 218 - 234
ISSN: 2615-6628 (E), ISSN: 1411-7177 (P)
Accredited SINTA 2

https://ojs.unud.ac.id/index.php/soca

Assessing Profitability Of Small-Scale Cocoa-Goat Mixed-Farming In West Sulawesi, Indonesia

Abrao Pereira[1], Stacey Paterson[2], Peter McMahon[2], David Guest[2], Agus Purwantara[3], and Jenny-Ann Toribio[1]

[1]Farm Animal Health, Sydney School of Veterinary Science, Faculty of Science, University of Sydney, Australia.

[2]School of Life and Environment Sciences, Faculty of Science, University of Sydney, Australia.

[3]PT Mars Symbioscience Indonesia, Jalan Kima 10, Makassar, South Sulawesi, Indonesia.

Correspondence e-mail: abajp@live.com

Submitted : October 6th, 2020 ; Revised : November 4th, 2020; Accepted: January 27th, 2021

Keywords: small-scale, mixed farming, cocoa, goat, cost benefit analysis

Abstract

Cocoa is a key crop for small-scale farmers in Sulawesi, Indonesia. Decline in cocoa yield and cocoa price fluctuation have negatively affected the income of small-scale farmers. An approach to address the sustainability of small-scale cocoa farming is to diversify the household income via cocoa-goat mixed farming. This study aimed to assess whether cocoa-goat mixed farming was a viable and profitable enterprise for small-scale farmers in West Sulawesi by using cost benefit analysis (CBA). Three CBA models were developed to compare profitability of an existing medium-scale cocoa-goat mixed farm located in West Sulawesi with hypothetical small-scale cocoa monoculture and cocoa-goat mixed farming. The CBAs were informed by an interview using structured questionnaire and literature search. The principal CBA assessment criterion was net present value (NPV) while benefit cost ratio (BCR) and internal rate of return (IRR) were supplementary. Sensitivity analysis measured the impact of changes in key parameters on profit. Over a 25-year production cycle, the medium-scale cocoa goat mixed farm is a profitable enterprise, earning an estimated profit of USD 90,403. At small-scale level, the findings suggest that engaging in small-scale cocoa goat mixed farming has potential to increase household income by 27% of profit from the cocoa monoculture.

How to Cite (APA 6th Style):
Pereira, A., Paterson, S., McMahon, P., Guest, D., Purwantara, A., & Toribio, and J.-A. (2021). Assessing Profitability Of Small-Scale Cocoa-Goat Mixed-Farming In West

Sulawesi, Indonesia. *SOCA: Jurnal Sosial Ekonomi Pertanian*, *15*(1), 218–234. https://doi.org/https://doi.org/10.24843/SOCA.2021.v15.i01.p20

INTRODUCTION

Cocoa is an important tree crop for small-scale farmers in Indonesia, providing livelihood for millions of resource-poor farmers. Indonesia is by far the biggest cocoa-producing country in the Asia-Pacific region and is among the largest producers in the world (Arsyad et al. 2011; ICCO, 2019). The industry generates USD 1.2 billion per annum (Witjaksono & Asmin, 2016), making cocoa an important agricultural export for Indonesia (Rifin & Nauly, 2013). As such, fluctuation in the world price for cocoa has an immediate influence on Indonesian cocoa industry. The world cocoa price varied from USD 2.3/kg to USD 3.5/kg over the last decade (ICCO, 2020). This fluctuation affects the farm-gate price in West Sulawesi which was as low as USD 1.4/kg in 2013 (Moriarty et al. 2014). The price fluctuation remains a major barrier to the small-scale farmers to improve management practices (AIC, 2018).

Cocoa production in Indonesia is concentrated on the island of Sulawesi accounting for 70% of national production (Witjaksono & Asmin, 2016). Around 90% of the producers in Sulawesi are small-scale farmers who individually own around 1 ha per farm (Irfany et al. 2017; Johnson et al. 2004; Lebe et al. 2017). It was the rapid expansion of small-scale cocoa farming between the 1980's and to the early 2000's that provided a large increase in cocoa production from Sulawesi (Neilson, 2007). However, several issues have begun to negatively affect cocoa production in Sulawesi and nationally. Over the last decade, annual cocoa bean yield in Sulawesi has declined from 1-1.5 tonnes/ha to less than 0.5 tonnes/ha (Janudianto et al. 2014). The decrease in cocoa yield is attributed to the combined effects of aging trees, declining soil fertility, adverse weather conditions, pests and diseases (Witjaksono & Asmin, 2016). These factors have collectively contributed to the recent poorer performance of small-scale cocoa farms. Thus, long term sustainability of cocoa production is threatened, and the income of small-scale farmers is considerably affected.

There have been many initiatives from the government and a variety of stakeholders to address the growing problem of decreased cocoa production in Sulawesi. The highlights in relation to government support include the National Cocoa Rehabilitation Program (GERNAS) from 2009 to 2015 (Aidenvironment, 2016) and the ongoing provision of fertilizer subsidy (FAO, 2017). Engaging in cocoa-livestock mixed farming has potential to improve farm profit through diversifying household income and provide resilience to crop-related problems and price fluctuation. Goats are a preferred livestock species for mixed farming as they are able to thrive in local conditions with minimal input by using a variety of poor quality feeds including crop by-products (Lebbie, 2004).

Adoption of mixed farming can be financially beneficial as the waste materials from one component are utilized as an input resource by the other in the crop-livestock system. Aside from the use of the cocoa by-products as goat feed, the goats provide manure which can be processed and utilized as compost for cocoa trees. The use of compost as organic fertilizer promotes faster growth and higher yield of cocoa on infertile soils as compared to inorganic fertilizer (Mulia et al. 2019). Based on the availability of cocoa by-products, 1 ha of cocoa has the potential to sustain 6 goats

(Rusdiana et al. 2014). This is based on an estimation that 1 ha of cocoa trees produce around 340 kg of cocoa pods annually, fed to the goats at 1.5 kg/goat each day in conjunction with prunings from cocoa and shade trees (Priyanto, 2008). Alternatively, Purwantara et al. (2017) estimated that 1 ha of cocoa farm is capable of supporting 22 goats. This estimation was based on a farm with the maximum number of leguminous shade trees possible among the cocoa trees and regular pruning of these trees.

To date there has been little research to assess the profitability of cocoa-goat mixed farming in Indonesia. Thus, the aim of this study was to evaluate the potential for cocoa-goat mixed farming to be a profitable and viable business. This is essential to improve long term livelihoods, income and resilience for cocoa farmers.

RESEARCH METHODS

Data collection

The study was conducted in the major cocoa producing province of West Sulawesi, Indonesia. The Bin Raji Farm (BRF) (coordinates -3.336793, 119.168056) was selected as a medium-scale cocoa-goat mixed farm which has sound management practice in West Sulawesi. A face-to-face interview was conducted with the farm owner and farm manager in November 2017 using a structured questionnaire. Open-ended questions were asked to request information about farm management, farm inputs and outputs. The questionnaire was developed in English and then translated into Bahasa Indonesia by a native speaker of Bahasa Indonesia based at the University of Sydney. The interview was approved by the Human Research Ethics Committee at The University of Sydney (Ethics approval number: 2017/891).

For the hypothetical small-scale cocoa monoculture farm and cocoa-goat mixed farm, secondary data were derived from expert opinion and published literature and from a household economic survey of small-scale cocoa farmers in West Sulawesi by Irfany et al. (2017).

Data analysis

Cost benefit analyses (CBA) were conducted from the perspective of cocoa farmers without considering the environmental and social costs and benefits. The time frame of the analysis is 25 years based on the projected economic life of the cocoa trees. The decision was made on this time frame to capture a full cycle of cocoa production.

Three CBA models were developed using Microsoft Excel 2016.

1. **Medium-scale enterprise.** The first CBA assessed the profitability of an existing medium-scale cocoa-goat mixed farm in West Sulawesi. This indicated how profitable a well-managed cocoa-goat mixed farm enterprise is under Sulawesi conditions and provided an understanding of the management and production procedures relevant to small-scale farmers in the local area.
2. **Small-scale cocoa monoculture.** The second CBA assessed the profitability of small-scale cocoa monoculture farming in West Sulawesi.
3. **Small-scale cocoa-goat mixed farming.** The third CBA assessed the profitability of small-scale cocoa-goat mixed farming in West Sulawesi.

The original monetary values of the costs and benefits were determined in Indonesian rupiah, which were converted to US dollars using an average exchange rate of 13,551 recorded within the period of 3 months from November 2017 – February 2018 (Bank Indonesia, 2018b). Since the costs and benefits occurred at different time periods, discounting to make them comparable at the present time was applied at 7.25% based on the average policy rate set for Indonesia in early 2018 (Bank Indonesia, 2018a). The policy rate is a rate used by central banks to manage supply of money including interest rate (International Monetary Fund, n.d.). Three assessment decision criteria were used in the evaluation of profitability. Net present value (NPV) was used as the main assessment criteria, while benefit cost ratio (BCR) and internal rate of return (IRR) were also calculated to supplement NPV. The NPV, BCR and IRR were calculated using the formulae outlined as follows (Rushton, 2009):

$$NPV = \sum \frac{B_T}{(1+r)^t} - \sum \frac{C_T}{(1+r)^t}$$

$$BCR = \frac{\sum \frac{B_T}{(1+r)^t}}{\sum \frac{C_T}{(1+r)^t}}$$

$$IRR = \sum \frac{B_T}{(1+r)^t} - \sum \frac{C_T}{(1+r)^t} = 0$$

Where:
B_T= total benefits
r= discount rate
t = number of years in the future
C_T = total costs

The summary of the three farm models are as follows:

1. Medium-scale cocoa-goat mixed farm

The medium-scale cocoa-goat mixed at BRF has 10 ha area for cocoa production. 8 ha is currently used for cocoa production with 1,000 cocoa trees/ha. The shade trees consisted of fruit trees (largely papaya and bananas) and leguminous trees (Gliricidia). Prunings of cocoa and shade trees as well as weeds and pod cases were used as goat feed.

In terms of goat production, the BRF records indicate that the current flock at the farm consists of 34 does with production cycle of 1.5/year. The average litter size was 2.0. Weaning is done at day 90. The flock is visited 4 times/year by a vet. An average of 102 yearlings is produced per year. The does are culled after 5 years while the bucks are culled when they are 8 years old. Adult goats were each fed 4.5 kg/day. Forages were purchased during the annual 3-month dry season at USD 0.02/kg. Farm tools and equipment purchased and used at the farm were backpack sprayers, wheelbarrow, grass cutters, hoes, pruning shears, machetes and knife. The price of these items based on the lazada.co.id as of February 2018.

2. Small-scale cocoa-monoculture farm

Information from the survey of Irfany et al. (2017) indicates that the average small-scale cocoa farm in West Sulawesi is 1.2 ha. Around 1,000 cocoa trees are planted per hectare (Moriarty et al. 2014), mainly local clones and Sulawesi 2 genotypes (Irfany et al. 2017). It is assumed in the model that the establishment rate

after planting and in-filling is 100%. The shade trees, mainly *Gliciridia*, a common legume shade tree in Sulawesi (Moser et al., 2010), are planted at the start of the cocoa farm in order to provide protection to the cocoa trees.

Fixed costs included purchase of seedlings and farm tools, and running costs, particularly labour. The land cost was not factored into CBA framework as it is not purchased specifically to establish a cocoa farm but owned by the farmer. Benefits were limited to the sale of cocoa beans.

Major farm inputs include seedlings that are generally acquired from neighbouring farms or a local nursery with the price of USD 0.37 - 0.74/seedling (Lebe et al. 2017). A major running cost is labour which is required according to the age of the cocoa trees (Bedford et al. 2002). Around 80-90 days per year/ha are needed for establishing and running non-bearing cocoa trees and then 30 days per year for bearing trees in a hectare of cocoa (Johnson et al. 2004). The daily wage used is USD 3.70/day based on the rate used at the BRF. Labour is required for a variety of activities including land preparation, planting, manual weeding, harvesting and post-harvesting operations. No external paid labour is required as the farm size is small and labour requirement is met fully by the farmer and the household members. It is assumed that small-scale cocoa farmers do not use fertilizer, pesticides and fungicide. This assumption was based on the report of Irfany et al. (2017) that the amount of fertilizers, pesticide and fungicide is negligible among small-scale farmers in West Sulawesi. The losses due to the pests and diseases are not factored in the CBA model. This is because the current poor production figure is assumed to already reflect pest and disease impacts. It is assumed that the old non-productive cocoa trees start to be replaced 3 years prior to the end of the production cycle.

The start of cocoa yield and the duration of production cycle are as described in earlier section under medium-scale cocoa-goat mixed farming. In relation to the production rate, it is assumed that in the first-year cocoa yield is only around 10%, and then yield gradually increases to 25%, 50%, 75%, 90% and 100% in the succeeding years. This assumption was constructed after consulting local cocoa experts. The peak of production varies but on average it may last around 8 years. After this point cocoa productivity starts to decline. An average annual production of dry cocoa beans from a small-scale cocoa farm in West Sulawesi is around 680 kg/ha (Irfany et al. 2017) but based on the author's consultation with an Indonesian cocoa expert, the yield may be as high as 800 kg/ha particularly when the cocoa trees are at the peak of production. The dry cocoa beans are sold to local collector (Lebe et al. 2017) at an average farm gate price estimate of USD 2.0/kg (VECO, 2011).

3. Small-scale cocoa-goat mixed farm

Information about the costs related to the cocoa component of the mixed farm is similar with small-scale cocoa-monoculture. As for the introduction of goats, the associated fixed costs include goat shed construction, goat and farm tools purchase. The running costs include maintenance costs, additional feed purchase, additional labour and miscellaneous.

The goat flock size is determined based on the carrying capacity of 1 ha cocoa farm. This was based on 90:1 shade tree to goat ratio per year as practiced at BRF.

Given that there are a total of 1,000 shade trees at the small-scale farm, it has potential to provide feed for around10 head of goats in a year.

The goat shed is assumed to be constructed on an area of marginal land on the cocoa farm which will not decrease the land area for cocoa. The goat shed is constructed using low-cost local materials with an estimated cost of US$ 200 for a flock size of 10 goats. The goat shed construction figure is based on an estimation of per head cost of goat shed which is around USD 20 according to an experienced goat raiser in the area.

Based on the assumption that a 1 ha cacao farm has a goat capacity of 10 head, the start-up goat flock size is determined to be 5 heads which consists of 4 does and 1 buck of PE (Peranakan Etawah). The initial breeding stock are purchased at an average price of USD 122 per buck and USD 104 per doe (Doloksaribu et al. 2014). Given the nature of small-scale goat management, it is assumed that the does are unlikely to achieve maximum production cycle of 1.5/doe/year. It is conservatively assumed that the production cycle is 1.0/doe/year while the litter size is 1.7 (Sodiq et al. 2003). Thus, it is expected that 5 does will produce 7 goats per year. Thus, it is estimated that together with initial breeding stock, an average of 10 goats will be maintained at the farm every year of which 5 goats are the initial breeding goats and 5 young stocks are produced and marketed annually. The breeding does are culled after around 5 years because at this point the doe productivity has significantly declined (Sodiq, 2004). The replacement of the does is implemented for 50% of does at Year 4 and the other 50% at Year 5. The buck is culled after around 8 years. The feed is largely derived from the legume shade trees.

The annual goat shed maintenance is estimated at USD 13. In terms of feeding, the prunings of shade trees, weeds and cocoa are used as feedstuff for goats which is given at 4.5 kg/doe/day (Priyanto, 2008). However, the prunings of the legume shade trees are not available all year round. During the long dry season from May to July (known as drought period) (Indonesian Metereological Climatological & Geophysical Agency, 2018) external feedstuff is purchased. The cost for an additional feed for the flock size of 10 goats is estimated around USD 82/year. This was calculated from the daily amount of consumption multiplied by the 90 days and the price of the forage USD 0.02/kg.

Additional labour is required to run the goat farm. Since the goat shed is located on the cocoa farm, this saves a substantial amount of time and labor in hauling the feed. It is estimated that the additional labor for the goat enterprise is 1 hour/day (Doloksaribu et al. 2014), thus, in total 48 days/year with a daily wage rate of USD 3.70 based on the rate used at BRF. In this model, family labour is not counted as part of the production cost as it is assumed to have been reflected in the annual total number of days needed to run the farm. The miscellaneous fee around USD 10/year was taken into account for unexpected expenses that might occur within the enterprise.

An estimate of 7 goat yearlings are sold per year with the price ranging from USD 65-110 (Murray et al. 2011). A substantial benefit is also derived from the legume shade trees. Having derived goat feed directly from the cocoa farm, the costs saved from purchasing forage is estimated at USD 248/year. This is calculated from multiplying the forage price USD 0.02/kg by the flock size and 4.5 kg (Priyanto, 2008)

daily feed intake and 9 months during which the shade tree prunings sufficiently available.

Sensitivity analysis

Sensitivity analysis measured the impact of a 50% increase or decrease of the baseline value of parameters in the estimate of NPV. The key parameters tested individually in the sensitivity analysis included: cocoa and goat price; cocoa yield; length of drought period; and the discount rate. These parameters were chosen as they are reported to influence cocoa and goat production. The sensitivity analysis was done by changing the value of each parameter while the other parameters are held at their base values.

RESULTS

Profitability of medium-scale cocoa-goat mixed farming

Information gained from the interview included costs of farm inputs such as fixed-costs involved in the establishment of the cocoa and goat farm and the running costs. The details of these costs are shown in Table 1.

Table 1. Costs of farm inputs at the medium-scale cocoa-goat mixed farm in West Sulawesi.

Items	Value	Source
a) **Cocoa component**		BRF records
Land price per ha (USD)	2,952	
Nursery shed (2) (USD)	1,106	
Maintenance of nursery shed (USD/year)	30	
Labour:		
Permanent staff	7	
Permanent staff' salary (USD/year/7 staff)	9,912	
Casual labour	3	
Casual labour daily wage (USD)	3.70	
Casual labour length of stay (day) in a year	30	
Fertilizers:		
year 1 (USD/year)	299	
years 2 (USD/year)	435	
year 3 (USD/year)	816	
year 4 and onward (USD/year)	952	
price per sack (USD/50kg)	8.5	
Fungicide (USD)	13	
Herbicide (USD)	144	
Polybag price (USD/kg)	2.6	
Utilities: electricity (USD/year)	708	
b) **Goat component**		
Goat shed (USD)	3,270	BRF records
Maintenance of goat shed (USD/year)	40	
Goat price:		
Buck (USD)	270	
Does (USD)	120	
Additional feeds during drought (USD)	163	

Treatment:	
Veterinary care per service (USD)	15
Medication (USD)	107
Miscellaneous	30
Farm tools and equipment (USD)	377

In relation to the benefits, the collected information included the major benefit streams such as cocoa bean sale, cocoa seedlings, and output derived from the shade trees. The benefits associated with the goat component included the sale of yearlings, culled goats, and increased yields resulting from manure application which was used in the farm as organic fertilizer. The details of the benefits are presented in Table 2.

Table 2. Benefits of the medium-scale cocoa-goat mixed farm in West Sulawesi.

Items	Value	Source
Average dry cocoa bean yield (kg/ha/year)	1500	BRF records
Average dry cocoa bean yield at peak (kg/ha/year)	2000	
Price of dry cocoa beans (USD/Kg)	2.00	VECO (2011)
Sale of cocoa seedling per year (USD)	5000	BRF records
Price of seedling (USD)	0.37	
Sale of papaya per year (USD)	540	
Sale of banana per year (USD)	101	
Start of cocoa yield (year)	3-5	ICCO (1998b)
Yearlings sold per year	102	BRF records
Flock size (goat number)	140	
Average birth type	Twin	
Price of yearlings (USD)	96	
Price of culled doe (USD)	83.00	Doloksaribu et al. (2014)
Price of culled buck (USD)	83.00	Doloksaribu et al. (2014)

Table 3. Cost and benefits of CBA of Medium-scale cocoa-goat mixed-farm in 25-year production cycle (2013-2037).

Year	Cost	Benefit	Net	Year index	Discount factor	Cost	Benefit	NPV	BCR	IRR
0	30,905	0	-30,905	0	1.00	30,905	0	-30,905	0.0	
2013	11,664	0	-11,664	1	0.93	10,875	0	-10,875	0.0	
2014	20,684	1,697	-18,987	2	0.87	17,982	1,475	-16,506	0.1	
2015	12,985	7,051	-5,934	3	0.81	10,526	5,716	-4,810	0.5	
2016	13,225	6,619	-6,606	4	0.76	9,996	5,003	-4,993	0.5	
2017	13,533	15,403	1,870	5	0.70	9,537	10,855	1,318	1.1	
2018	15,628	25,694	10,066	6	0.66	10,269	16,883	6,614	1.6	
2019	15,667	31,694	16,027	7	0.61	9,599	19,418	9,819	2.0	
2020	13,777	44,283	30,506	8	0.57	7,870	25,296	17,426	3.2	
2021	14,317	44,449	30,132	9	0.53	7,626	23,675	16,049	3.1	
2022	14,595	44,449	29,854	10	0.50	7,248	22,074	14,826	3.0	
2023	15,928	45,694	29,766	11	0.46	7,375	21,159	13,783	2.9	
2024	15,817	45,694	29,877	12	0.43	6,829	19,728	12,899	2.9	
2025	13,777	44,283	30,506	13	0.40	5,546	17,827	12,281	3.2	

2026	13,777	44,283	30,506	14	0.38	5,171	16,622	11,450	3.2	
2027	14,055	44,283	30,228	15	0.35	4,919	15,498	10,579	3.2	
2028	15,898	36,494	20,596	16	0.33	5,188	11,909	6,721	2.3	
2029	16,297	35,460	19,163	17	0.30	4,959	10,789	5,830	2.2	
2030	14,227	32,849	18,622	18	0.28	4,036	9,319	5,283	2.3	
2031	13,597	29,083	15,486	19	0.26	3,597	7,693	4,096	2.1	
2032	13,815	26,683	12,868	20	0.25	3,407	6,581	3,174	1.9	
2033	15,628	25,694	10,066	21	0.23	3,594	5,909	2,315	1.6	
2034	15,457	23,294	7,837	22	0.21	3,314	4,995	1,680	1.5	
2035	12,858	19,483	6,625	23	0.20	2,571	3,895	1,324	1.5	
2036	12,798	17,083	4,285	24	0.19	2,386	3,184	799	1.3	
2037	13,556	14,849	1,293	25	0.17	2,356	2,581	225	1.1	
Total	394,466	706,548	312,082			197,679	288,082	90,403	1.5	16.4%

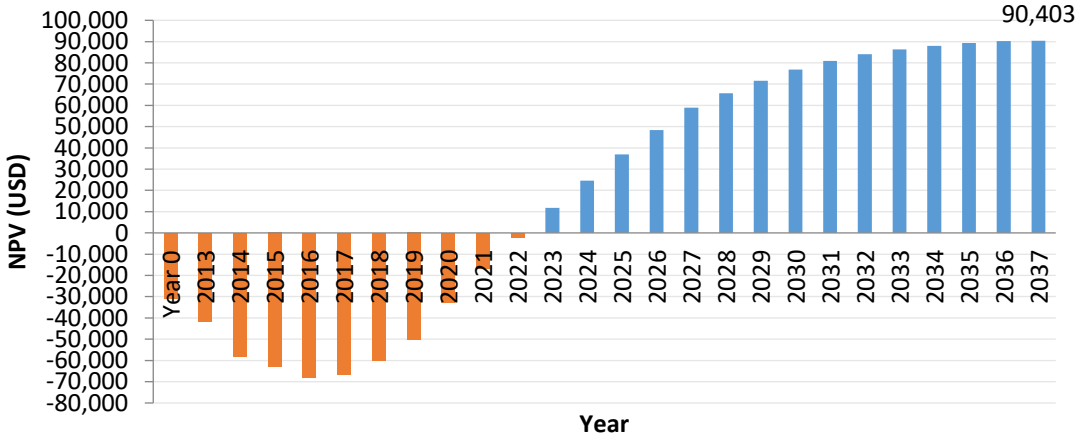

Figure 1. Cumulative NPV of the medium-scale cocoa-goat mixed-farm in West Sulawesi during the 25-year production cycle (2013-2037).

The medium-scale cocoa-goat mixed farm had negative cumulative NPV for around 10 years. It was estimated that the investment starts to earn positive NPV at year 2023. The NPV increases more gradually towards the end of the 25-year production cycle reaching a total of USD 90,403 at 16.4% IRR and the BCR of 1.5 (Table 03).

The breakdown of the costs and benefit of the medium-scale cocoa-goat mixed farm over the 25-year production cycle is presented in Table 3. Labour constitutes the highest production cost followed by fertilizer purchase (Table 3). More than half of the benefits in the medium-scale mixed-farm are derived from the sale of dry cocoa beans. The inclusion of goat rearing substantially diversified the farm income, accounting for nearly 30% of the total benefit.

Table 4. Total costs and benefits of the medium-scale cocoa-goat mixed farm in West Sulawesi during the 25-year production cycle (2013-2037).

Costs		USD (%)[1]
Fixed costs:		39,445 (10)
Running costs:		
Labor		268,409 (68)
Utilities		17,700 (4.5)
Fertilizer		21,066 (5.3)
Fungicide & herbicide		3,912 (0.9)
Polybags & plastic sleeves		9,358 (2.4)
Compost starter		935 (0.2)
Hand tractor renting		1,948 (0.5)
Transportation		500 (0.1)
Maintenance of nursery shed		750 (0.2)
Replacement of farm tools & equipment		1,832 (0.5)
Goat feed (during long dry period)		3,912 (0.9)
Goat medication and veterinary care		4,008 (1)
Goat replacement		19,020 (4.8)
Goat shed maintenance		920 (0.2)
Miscellaneous		750 (0.2)
	Total	394,466
Benefits		
Cocoa bean sale		426,160 (60.3)
Cocoa seedlings		42,550 (6.0)
Goat yearling sale		210,336 (29.8)
Culled goat sale		12,118 (1.7)
Sale of fruit shade tree output		15,384 (2.2)
	Total	706,548

[1]the number in the bracket shows the percentage of the total cost or the total benefit.

Profitability of small-scale cocoa-monoculture farm and cocoa-goat mixed farm

The CBA results for the small-scale cocoa monoculture and cocoa-goat mixed-farming are presented in Figure 2. Integrating goats into the small-scale cocoa farm requires an additional investment of more than USD 900 or around 262% ($\frac{1,361-375}{375}$) of the initial capital used for small-scale cocoa farm (Table 5). The benefit in the cocoa monoculture farm is solely derived from the sale of cocoa beans while in the cocoa-goat mixed farm the benefits derived principally from the sale of cocoa beans, goat yearlings and culled goats (Table 5).

Table 5. Total costs and benefits of the hypothetical small-scale cocoa monoculture and small-scale cocoa-goat mixed-farm in West Sulawesi over a 25-year production cycle.

	Small-scale cocoa monoculture farm (USD) (%)[1]	Small-scale cocoa-goat farm (USD) (%)[1]
Costs		
Fixed cost	375 (7.7)	1,361 (8.6)
Running costs:		
Labour	3,793 (78.3)	7,622 (48.2)
Cocoa tree	370 (7.6)	703 (4.4)
Miscellaneous	250 (5.1)	250 (1.6)
Goat replacement	-	2,970 (18.8)
Farm tool	25 (0.5)	169 (1.1)
Goat feed during drought	-	2,430 (15.4)
Goat-shed	-	312 (1.9)
Total	**4,813**	**15,817**
Benefits		
Cocoa bean sale	23,680 (100)	23,680 (58)
Goat yearling sale	-	15,667(38)
Culled goat sale	-	1,800 (4)
Total	**23,680**	**41,147**

[1]Figure in the bracket shows the percentage of the total cost or the total benefit.

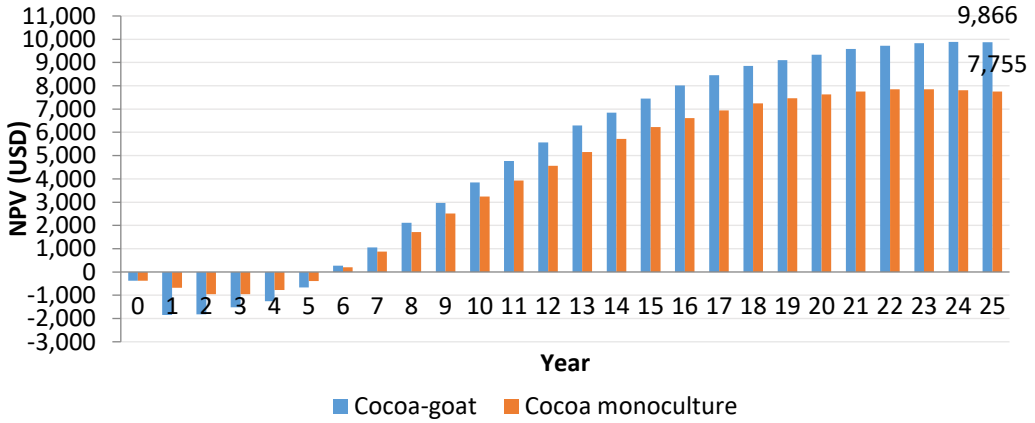

Figure 2. Cumulative NPV of the small-scale cocoa-goat mixed farm and cocoa monoculture farm in West Sulawesi over a 25-year production cycle.

From the cumulative NPV (Figure 2), both small-scale cocoa-goat mixed farm and small-scale cocoa monoculture farm have negative NPV from Years 0-5 which indicates that the income generated within this period is not sufficient to outweigh the production costs. However, both farming systems have positive NPV over the 25-

year production cycle which is an indication that both enterprises are financially viable.

Integrating goats into small-scale cocoa farming increases the NPV of the small-scale cocoa monoculture by 27% ($\frac{9,866-7,755}{7,755}$) (Figure 2) over the 25-year cocoa production cycle. Nevertheless, the results also show that the IRR and BCR of the small-scale cocoa monoculture farm are higher as compared to small-scale cocoa monoculture farm.

Sensitivity Analysis

Cocoa yield and cocoa price were two critical parameters found to substantially influence farm profitability (Tables 6 and 7). For the medium-scale farm, when the cocoa price/cocoa yield decreases or increases by 50%, it changes NPV by 98%. For a small-scale farm, when there is a decrease or increase of cocoa yield or cocoa price by 50%, the baseline NPV changes by 65% and 51% in cocoa monoculture and cocoa-goat mixed farm, respectively. The changes of the cocoa yield and price have similar effects on baseline NPV as shown in Table 6 and 7. This is because the cocoa yield and cocoa price are closely interrelated. The effect of the cocoa price change on the profit is also dependent on the volume of cocoa yield and vice versa.

In cocoa-goat mixed farming, the price of yearlings and length of drought period are potential parameters that influence the NPV. For the medium-scale farm, the NPV tends to increase/decrease by 46% when the yearling sale price is high or low. For the small-scale farm, the price tends to influence the NPV by 35% when there is increase or decrease of the goat yearling price. The length of drought period was influential only for the small-scale farms, with estimated influence on the NPV by 6% when the drought period was 50% shorter or longer than usual.

Table 6. Sensitivity analysis of NPV to the changes in the key parameters in the medium-scale cocoa-goat mixed farm.

Parameters	NPV (USD) at parameter input value			Δ in NPV (%)
	Low (-50%)	Baseline	High (+50%)	
Cocoa price (USD)	2,204	90,403	178,602	-/+ 98
Cocoa yield	2,204	90,403	178,602	-/+ 98
Discount rate	171,646	90,403	155,426	90, 72
Price of the yearlings	49,223	90,403	131,583	-/+ 46

Table 7. Sensitivity analysis of the estimated NPV to the changes in the key parameters in small-scale cocoa-goat mixed farm and cocoa monoculture farm.

Parameters	Small-scale cocoa monoculture farm				Small-scale cocoa-goat mixed farm			
	NPV (USD) at parameter input value			Δ in NPV (%)	NPV (USD) at parameter input value			Δ in NPV (%)
	Low[1] (-50%)	Baseline	High[2] (+50%)		Low[1] (-50%)	Baseline	High[2] (+50%)	

Cocoa price (USD)	2,721	7,755	12,788	-/+ 65	4,833	9,866	14,900	-/+ 51
Cocoa yield	2,721	7,755	12,788	-/+ 65	4,833	9,866	14,900	-/+ 51
Discount rate	11,938	7,755	5,127	+47	15,573	9,866	6,360	+58, -36
Yearlings price	-	-	-	-	6,451	9,866	13,282	-/+ 35
Drought length	-	-	-	-	10,420	9,866	9,313	+/- 6

[1] Low reflects 50% decrease in the baseline value of the parameter.
[2] High reflects a 50% increase in the baseline value of the parameter.

DISCUSSION

Productive cocoa farming requires regular management to remove excess shade and weeds, diseased cocoa branches and pods, stimulate flowering and pod maturation. However the benefits of improved management are deferred, in that investments in labour and management are not repaid until pod harvests increase several months later and farmers may direct their resources to more immediate priorities. Incorporating goats into the cocoa farming system provides an immediate incentive for farmers to remove waste products as feed for the animals, producing supplementary income and protein nutrition. Manures can be composted to improve soil fertility and increase cocoa yields in the medium term. This analysis provides, for the first time, direct evidence that cocoa-goat mixed farming is profitable over a 25 year cocoa cropping cycle.

Aside from the additional benefits of having goats, goat sales contributed almost 30% of the total income (Table 4). At the small-scale level, the CBA results show that engaging in cocoa-goat mixed farming has potential to increase the profitability of small-scale cocoa monoculture farms over a 25-year production cycle by around 27% (Figure 2). This is lower than suggested in a previous study by Gunawan & Budisatria (2016) which reports 70% higher profits in small-scale cocoa-goat mixed farms compared to cocoa monoculture in Java. However, it was unclear how the financial assessment was conducted in the study by Gunawan & Budisatria (2016) and the production stages of the cocoa trees on farms in the study was not reported.

Establishing the cocoa-goat mixed farm means additional investment by as much as 262% compared to cocoa monoculture (Table 4). This may be a considerable constraint to small-scale farmers who may have difficulty sourcing the required additional capital to establish the mixed farm enterprise. A bank loan as a source of finance might be an option but Irfany et al. (2017) found that most small-scale cocoa farmers in West Sulawesi do not have a bank account or are reluctant to receive bank loans. However, credit schemes such as Kredit Usaha Rakyat (KUR) recently initiated by the Government of Indonesia and backed by two state-owned corporations will enable readier access to finance among rural smallholders (Nunung Nurayartono, pers. comm.). International non-government organizations established to empower cocoa smallholders, such as Swiss Contact and Rikolto (formerly VECO), provide training and other programs to facilitate access to finance for farm inputs.

Additional benefits of raising goats in the cocoa mixed farm are derived from the production of goat manure that can potentially be used as a source of organic

fertilizer for the cocoa trees. A study in South Sulawesi that applied cattle manure-based compost to cocoa trees reported around 5 times higher cocoa yield as compared to inorganic fertilizer (Mulia et al. 2019). Soil organic matter (SOM) plays a key role in promoting nutrient availability and microbial activity in tropical soils (Tiessen et al. 1994; Burger & Jackson, 2003). Cocoa farming generally results in depletion of soil organic matter (SOM), frequently to levels below the minimum recommended for optimal cocoa production (Agoume & Birang, 2009). This is a serious problem in many cocoa-producing areas of Sulawesi (Mulia et al. 2019) and soil amendment using compost and other sources of organic matter is a priority, especially as small-scale farmers currently face declines in farm productivity (Moriarty et al. 2014). Applying manure-based composts in mixed farm systems improves SOM and thereby crop productivity. The preparation of goat manure-based compost is worth investigation taking into consideration costs of additional labour and the compost starter, and the effect on cocoa yield.

All the three CBAs have positive NPV over the 25-year production cycle. Sensitivity analysis indicated the estimated NPV over 25-year period is very sensitive to changes in the cocoa yield and price. When there is decrease or increase in cocoa yield and price it substantially changes the estimated NPV (Table 6 and 7). However, the changes are less pronounced for cocoa-goat mixed farm. Therefore, the diversification of farm enterprise with integration of goat raising into the farm can make an important contribution to household income security by acting at least as a buffer to losses in the event that both cocoa yield and price decrease.

A limitation of this study relates to uncertainty about the influence of other parameters such as the application of fertilizer and of fungicide and herbicide use on profitability that were not investigated in the sensitivity analysis. These were not included as their use was limited to the medium-scale farm, being reported only for the BRF. Given that fertilizer and pesticides are viewed as key inputs for cocoa farms due to their substantial impact on cocoa yield and on profitability, further evaluation of profitability for small-scale cocoa-goat mixed farm compared to cocoa monoculture accounting for these inputs is warranted.

CONCLUSION

Engaging in small-scale cocoa goat mixed farming provides a viable medium and long-term supplement to cocoa monoculture that improves profitability, income diversification and nutrition for cocoa farmers in West Sulawesi, Indonesia. The standard of management required for successful cocoa-goat mixed farming in this region was demonstrated by an established successful medium-scale enterprise. There is potential for a small-scale cocoa-goat mixed farm to increase household income by 27% compared to cocoa alone. It takes around 5-year period to realize the benefits of engaging in small-scale cocoa-goat mixed farming and large establishment cost is involved.

For small-scale cocoa farmers to realize such benefits from mixed farming will require long-term planning and a mechanism to provide capital investment adequate to finance establishing the goat herd in addition to the cocoa trees. Given that new knowledge about goat management particularly reproduction and health is required

to support the expected annual production of yearlings for sale, access to training in goat raising for farmers also needs consideration.

ACKNOWLEDGEMENT

This study was funded by the Australia-Indonesia Centre (AIC) through a project entitled "Sustainability and profitability of cocoa-based farming systems in Indonesia". The authors would also like to acknowledge the assistance provided by the BRF staff. This work formed part of the master's dissertation of Abrao Pereira for studies funded by an Australia Awards scholarship.

REFERENCES

Aidenvironment. (2016). Evaluation of UTZ in the Indonesian cocoa sector. Netherlands: Aidenvironment. https://www.standardsimpacts.org/sites/default/files/UTZ_in_the_indonesian_cocoa_sector_2016.pdf

AIC. (2018). Sustainability and profitability of cocoa-based farming system in Indonesia. Melbourne, Australia

Agoume, V., Birang, A.M. (2009). Impact of Land-use Systems on some Physical and Chemical Soil Properties of an Oxisol in the Humid Forest Zone of Southern Cameroon. Tropicultura, 27, 15-20.

Arsyad, M., Sinaga, B. M., & Yusuf, S. (2011). Analysis of the impact of export tax and price subsidy policies on Indonesian cocoa exports and production post-Uruguay round. *Jurnal Sosial Ekonomi Pertanian*, 8(1), 63–71. http://103.195.142.17/handle/123456789/715

Bank Indonesia. (2018a). *BI rate*. Retrieved from http://www.bi.go.id/en/moneter/bi-rate/data/Default.aspx

Bank Indonesia. (2018b). *Foreign exchange rate.* Retrieved from http://www.bi.go.id/en/moneter/informasi-kurs/transaksi-bi/Default.aspx

Bedford, A., Blowfield, M., Burnett, D., & Greenhalgh, P. (2002). Value chains: lessons from the Kenya tea and Indonesia cocoa sectors. Technical report in Focus 3. London, UK.: Natural Resources Institute and the Resource Centre for the Social Dimension.

Burger, M., Jackson, L.E. (2003). Microbial immobilization of ammonium and nitrate in relation to ammonification and nitrification rates in organic and conventional cropping systems. Soil Biology & Biochemistry,35, 29-36. https://doi.org/10.1016/S0038-0717(02)00233-X

Doloksaribu, L., McLachlan, B. P., Copland, R. S., & Murray, P. J. (2014). Constraints to, challenges of, and opportunities for rearing goats in Bali Province. *A case study: Rearing goats in Karangasem Regency*. International Conference on Agriculture, Biology and Environmental Sciences, Bali, Indonesia.

FAO [Food and Agriculture Organization]. (2017). *Country factsheet on food and agriculture policy trend*s. Retrieved from http://www.fao.org/3/a-i7696e.pdf

Gunawan, & Budisatria, I. G. S. (2016). Technology innovation in cocoa-goats integration system for increasing of productivity and farmers income in Kulon Progo Regency, Yogyakarta Special Region Province, Indonesia. *Asian Journal of Animal Sciences*, *10*(6), 273–279. https://doi.org/10.21059/buletinpeternak.v41i4.25002

ICCO [International Cocoa Organization]. (1998). How much time does it take for a cocoa tree to become productive? https://www.icco.org/faq/57-cocoa-production/129-how-much-time-does-it-take-for-a-cocoa-tree-to-become-productive.html

ICCO. (2019). Quarterly Bulletin of Cocoa Statistics Cocoa year 2018/19. https://www.icco.org/statistics/production-and-grindings/production.htm

ICCO. (2020). May 20 quarterly bulletin of cocoa statistics. https://www.icco.org/about-us/icco-news/419-may-2020-quarterly-bulletin-of-cocoa-statistics.html

International Monetary Fund. What is the central bank policy rate? Retrieved from http://datahelp.imf.org/knowledgebase/articles/484375-what-is-the-central-bank-policy-rate

Irfany, I, M., Nuryartono, N., Kiki, A., Sidik, D., Kim, Mcmahon, P. J., & Guest, D. (2017). Improving cocoa smallholder livelihoods in Sulawesi: strategies and interventions. *Unpublished*.

Janudianto, J., Roshetko, J. M., & Mahrizal, M. (2014). Cacao Agroforestry System (CAS) improving productivity and profitability of smallholder cacao in Sulawesi. World Congress on Agroforestry, Dehli, India.

Johnson, G. I., Iswanto, A., Ravusiro, J., Keane, P. J., Holiwood, N., Lambert, S. V., & Guest, D. I. (2004). Linking farmers with market: the case of cocoa. *ACIAR Proceedings No. 119e*. Canberra.

Lazada. (2018). Retrieved from https://www.lazada.co.id/co.id

Lebbie, S. H. B. (2004). Goats under household conditions. *Small Ruminant Research*, *51*, 131–136. https://doi.org/10.1016/j.smallrumres.2003.08.015

Lebe, D., Fahdli, Z., & Philips, M. (Eds.). (2017). Access to finance: The cocoa sector training for financial institutions. http://www.swisscontact.org/fileadmin/user_upload/COUNTRIES/Indonesia/Documents/Publications/110917_-_Bank_Training_Manual_-_FINAL_-_web_version.pdf

Moriarty, K., Elchinger, M., Hill, G., Katz, J., Barnett, J. (2014). Cacao Intensification in Sulawesi: A Green Prosperity Model Project, *MCA*. Report NREL/TP-5400-62434. Millenium Challenge Account, Produced under direction of the Millennium Challenge Corporation by the National Renewable Energy Laboratory (NREL) under Interagency Agreement IAG-12-1866 and Task No WFQ9.1017.

Moser, G., Leuschner, C., Hertel, D., Hölscher, D., Köhler, M., Leitner, D., Michalzik, B., Prihastanti, E., Tjitrosemito, S.,& Schwendenmann, L. (2010). Response of cocoa trees (*Theobroma cacao*) to a 13-month desiccation period in Sulawesi, Indonesia. *Agroforestry Systems,79*(2), 171–187. https://doi.org/10.1007/s10457-010-9303-1

Mulia, S., McMahon, P., Purwantara, A., Djufry, F., Lambert, S., Keane, P., Guest, D., (2019). Effect of organic and inorganic amendments on productivity of cocoa on a marginal soil in Sulawesi, Indonesia. *Experimental Agriculture*,55, 1-20. https://doi.org/10.1017/S0014479717000527

Murray, P., Murray-Prior, R., Atsir, A., Asja, M., Nasrullah, Yusmasari, & Nurhayu, A. (2011). Improving goat production in integrated estate cropping systems in South Sulawesi. Canberra, Australia: Australian Center for International Agricultural Research.

Neilson, J. (2007). Global markets, farmers and the state: Sustaining profits in the Indonesia cocoa sector. *Bulletin of Indonesian Economic Studies*. *43*(2): 227–250. https://doi.org/10.1080/00074910701408073

Priyanto, D. (2008). Model usaha tani integrasi kakao kambing dalam upaya peningkatan pendapat petani. *Wartazoa*. *18*, 46–56.

Purwantara, A., Peters, M., Faisal, Sunarya, Neilson, J., Lambert, S., Keane, P. & Guest, D. (2017). Microbial study on fertilizer trials and compost production on cocoa through integration with goats. Indonesia.

Rifin, A., & Nauly, D. (2013). The effect of export tax on Indonesia's cocoa export competitiveness. AAERES Annual Conference, New South Wales, Australia

Rusdiana, S., & Martono, B. (2014). Financial analysis of business diversification of cocoa plantation and goat farming. *Sikuler Inovasi Tanaman dan Penyegar/SIRINOV,*2(3), 157–170.

Rushton, J. (2009). *The economics of animal health and production*. London, U.K.: CAB International.

Sodiq, A. (2004). Doe productivity of peranakan etawah goats and factors affecting them in Indonesia. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*. Retrieved from https://www.uni-kassel.de/upress/online/frei/978-3-89958-074-7.volltext.frei.pdf

Sodiq, A., Adjisoedarmo, S., & Tawfik, E. S. (2003). Reproduction rate of kacang and peranakan etawah goats under village production systems in Indonesia. *International Research on Food Security, Natural Resource Manageement and Rural Development*, Gottingen, Germany.

Tiessen, H., Cuevas, E., Chacon, P. (1994). The role of soil organic matter in sustaining soil fertility. Nature.371: 783-785. https://doi.org/10.1038/371783a0

VECO. (2011). Increased incomes for Indonesian cocoa farmers in sustainable markets: NGO-private sector cooperation on Sulawesi island. http://exchange.growasia.org/system/files/indonesia-cocoa-case.pdf

Witjaksono, J., & Asmin. (2016). Cocoa Farming system in Indonesia and its sustainability under climate change. *Agriculture, Forestry and Fisheries*. *5*(5): 170. http://dx.doi.org/10.11648/j.aff.20160505.15