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Pria Sembada

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présentée par

Pria SEMBADA

**Transformation des systèmes bovins laitiers en
Indonésie : évaluation de la durabilité et des
trajectoires des exploitations**

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**Transformation of dairy production systems in
Indonesia : assessing sustainability and
long term trajectories of farms**

Foreword

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Contents

Foreword	3
Contents	4
List of Figures	6
List of Tables	8
Résumé Long	10
GENERAL INTRODUCTION	23
1. Dairy sector in Indonesia	24
2. The importance of smallholder farm.....	42
3. Problem Statement.....	45
4. Research question	46
MATERIAL AND METHOD	47
1. State of Art	48
2. Time and study area.....	52
3. Research framework	55
4. Research phases	57
CHAPTER 1. The role of dairy development project	60
CHAPTER 2. The importance of working capital in the sustainability of smallholder farms in West Java (Indonesia)	79
CHAPTER 3. Understanding farm trajectories in the development of dairy production in Indonesia: case study in West Java Province	103
DISCUSSION	126
1. Sustainability of smallholder farms.....	128
2. In what conditions, smallholders farm will be more sustainable?.....	135
CONCLUSION	140
REFERENCES	143
ANNEXES	151
1. Questionnaire for chapter 1	152
2. Questionnaire for chapter 2	163
3. Multivariate analysis for pattern of sustainability	171
4. Multivariate analysis for type of farm	173
5. Correspondance analysis to make a link between pattern of sustainability and type of farm.....	175

6. Indepth interview and monogram for chapter 3	176
Abstract	251
Résumé	252

List of Figures

Figure 1 milk production in Indonesia from 2011 to 2015	27
Figure 2 Import of dairy product from 1961 to 2012	27
Figure 3 The history of dairy sector in Indonesia.....	30
Figure 4 Map of value chain in Ciater (West Java Province) (Source: Duteurtre, et al., 2016).....	34
Figure 5 Milk flow from farmers to consumers in West Java (KPSBU cooperative) (Source: CIRAD survey, 2014)	35
Figure 6 Farmers delivery milk to milk collecting point by walking (a) or motorcycle (b)	37
Figure 7 Farmers are at milk collecting point.....	37
Figure 8 Cooperative staff carry out a milk rapid test.....	38
Figure 9 Cooling truck to transport milk from farmers to KPSBU	38
Figure 10 Cooling trucks arrive at KPSBU	39
Figure 11 KPSBU staff is preparing to store the milk in the cooling tank.....	39
Figure 12 Delivery truck to transport dairy product from KPSBU	40
Figure 13 Problem of the dairy farming system toward sustainability.....	45
Figure 14 Main question and sub-questions of the study	46
Figure 15 The MESMIS evaluation framework: linking attributes for sustainability to indicators	51
Figure 16 Map of Study area in Bandung Barat Regency and Subang Regency, West Java Province.....	54
Figure 17 Main phases of the study from 2014 to 2017	55
Figure 18 research framework.....	56
Figure 19. Study phase in Bandung Barat and Subang district Indonesia.....	58
Figure 20. The Demo Farm in Ciater	64
Figure 21 The “other” farm in Ciater	64

Figure 22 Forage included cultivated grass (a), natural grass (b), paddy straw, and silage (d)	68
Figure 23 Tofu waste (a) and concentrate feed (b).....	69
Figure 24 Milk per farm sold to KPSBU by farmers in Ciater (2010 to 2014).....	73
Figure 25 Number of dairy farmers in Ciater who delivered milk to KPSBU (2010 to 2014).....	73
Figure 26 Increase in the price of milk collected and in the price of feed concentrate sold by KPSBU (2010-2014).....	74
Figure 27 Sustainability pattern.....	93
Figure 28 Forestry land owned by Perhutani that can be accessed by dairy farmers.....	98
Figure 29 land of PTPN for tea plantation (a) and unused land that is accessible for farmers	99
Figure 30 Biogas installation in the farm	100
Figure 31 Percentage of farms with the net dairy income per family worker above the threshold of the mean annual salary of an unskilled worker according to the herd size	110
Figure 32 Six farm trajectories based on activities, land access and herd growth	115

List of Tables

Table 1 Consumption of dairy product in Indonesia from 2009 to 2014	28
Table 2 Number of farms for each assessment.....	58
Table 3 Survey of farms	65
Table 4 Farmers' education level	67
Table 5 Age of farmers.....	67
Table 6 Farmer's experience in dairy farming	67
Table 7 Farmers' access to land in 2014	67
Table 8 Dairy farming facilities and practices.....	70
Table 9 Technical-economic performance of dairy farms.....	71
Table 10 Comparison of the milk productivity per farm and of net income in Ciater in 2010 and 2014	72
Table 11 The attribute, critical points, criteria and indicators of sustainability of dairy farming system in study areas	85
Table 12 Indicators and its level of importance from three pillars of sustainability of dairy farming system in study areas	86
Table 13 Scoring method of six variables of sustainability	89
Table 14 Farm description in study areas.....	91
Table 15 Pattern based on sustainability score (1-100).....	92
Table 16 Structure, dairy farming practices, and technical-economic performance of dairy farm	95
Table 17 link between feeding system and pattern of sustainability (number of farm) .	96
Table 18 Net dairy income par family worker according to the herd size	109
Table 19 Characteristics of the four farm types (mean value and standard deviation)	111
Table 20 Economic performances and productivity of the production factor (labour, land and herd) of the four farm types	112

Table 21 Technical and economic results of the dairy activity according to the four farm types.....	113
Table 22 Development of herd size since beginning of dairy farming activity until 2017	114
Table 23 Nutritive value of feeds	119
Table 24 link between type of farm and pattern of sustainability	129

Résumé Long

Introduction

En Indonésie, la croissance économique rapide et l'intérêt des consommateurs pour des aliments de bonne qualité nutritionnelle stimulent la consommation d'aliments d'origine animale, y compris les produits laitiers. Cet essor de la consommation par habitant se double d'une croissance démographique rapide, notamment dans les villes. En réponse, le PIB du sous-secteur de l'élevage a augmenté de plus de 56% sur cinq ans (2011-2015). Même si la consommation par habitant reste relativement faible par rapport aux autres pays d'Asie du Sud-Est, la demande en produits laitiers est passée de 3 à 14 kg EL par habitant et par an au cours des 30 dernières années. Face à cette forte progression des quantités consommées, la production nationale est en forte croissance. Elle a atteint 835 000 tonnes en 2015, soit 23 % de la consommation intérieure. Cette production est principalement réalisée par de petites exploitations. Les petites exploitations de moins de 20 vaches regroupent 95 % du cheptel laitier national. Avec seulement 4 vaches et moins de 1 hectare de terres cultivées par ménage en moyenne, les activités laitières jouent un rôle important dans la sécurisation des moyens de subsistance de ces petites exploitations. Cependant, ces fermes font face à plusieurs contraintes qui remettent en question leur contribution au développement durable.

Cette question de l'élevage laitier familial et du développement laitier durable est une problématique très générale. Pour de nombreux producteurs laitiers dans le monde, les prix élevés des intrants et les faibles rendements liés aux pratiques d'élevage mal maîtrisées (alimentation, logement, santé) sont les principaux défis IFCN (2005). En outre, les facteurs socio-économiques, comme les difficultés d'accès au foncier et au crédit, ou l'organisation des marchés aux échelles locales, nationales et mondiales, ainsi que les questions environnementales et les problèmes liés à la qualité du lait sont importants à traiter (Devandra, 2003 ; Nkya et al., 2007 ; Moran, 2009 ; Poulton et al., 2010 ; Tebug et al., 2012, Atuhaire et al., 2014).

Ces études montrent en particulier que les diverses contraintes auxquelles font face les petites exploitations laitières, se résument le plus souvent à une "pénurie de capitaux".

La pénurie de capitaux devient le principal défi que doivent relever les petites exploitations. Les agriculteurs font face non seulement au manque de capital physique, mais aussi au capital humain, au capital social et au capital technique (Khanh et al., 2017; Bosc, et al., 2015). Les agriculteurs réagissent différemment à ces limitations. Certains éleveurs s'adaptent en diversifiant leurs sources de revenus, par d'autres activités agricoles (García-Arias et al., 2015, Meraner et al., 2015) et des activités non agricoles (Barrett et al., 2001, García-Arias et al., 2015). Cependant, d'autres choisissent d'abandonner les activités laitières (García-Arias et al., 2015).

Face à ces difficultés et aux incertitudes auxquelles les petites exploitations familiales font face, nous posons la question suivante : «L'élevage laitier est-il pertinent pour sécuriser ou maintenir les moyens de subsistance des petits exploitants ruraux? Au-delà de la question des revenus pour les exploitations familiales (pilier social et économique), il est important également de considérer les questions liées aux impacts de l'élevage sur l'environnement, notamment au travers de la gestion des effluents d'élevage (pilier environnemental) ? Enfin, ces petites exploitations laitières peuvent contribuer à l'approvisionnement du marché national en lait local et ainsi participer à la sécurité alimentaire (pilier social et économique). Ainsi, nous formulons notre question de recherche de la façon suivante : «Dans quelles conditions les petites exploitations laitières participent-elles au développement durable ?». Notre thèse est que l'activité laitière est intéressante, sous certaines conditions d'accès au capital, pour maintenir des petites exploitations familiales dans un processus de développement durable.

Les objectifs de l'étude sont donc les suivants: premièrement, mieux comprendre la situation actuelle des petites exploitations laitières familiales; deuxièmement, évaluer, à un instant donnée (approche synchronique) la durabilité des systèmes d'élevage laitier; troisièmement, évaluer la dynamique et les changements des systèmes laitiers, c'est-à-dire avoir une approche diachronique de la durabilité.

Pour mieux comprendre la durabilité des systèmes d'élevage laitier en Indonésie, une étude a été menée à Subang et à Bandung Barat, dans la province de Java-Ouest. Ces zones ont été choisies parce que le gouvernement avait établi ces zones en tant que centre

de production laitière en Indonésie. L'étude s'est concentrée sur un diagnostic des systèmes présents aujourd'hui et l'évaluation de leur durabilité. Il s'agit de comprendre pourquoi certaines fermes ont une meilleure durabilité, globalement ou dans certaines dimensions. Au-delà de cette approche synchronique, une étude a été réalisée pour mieux comprendre les choix des petites exploitations et la dynamique de leur exploitation vers la durabilité, par une approche diachronique. L'enjeu est de pouvoir discuter de l'activité laitière comme support d'un développement durable pour les petites exploitations familiales et d'ouvrir des pistes de réflexion sur les leviers pour renforcer cette durabilité, en fonction de la diversité de ces petites exploitations.

Dispositif de recherche

Pour évaluer et comprendre comment se construit la durabilité des petites exploitations laitières familiales, un dispositif de recherche sur trois ans a été construit. Tout d'abord, une étude a été menée pour identifier le rôle d'un projet de développement laitier dans le site d'étude (première phase, en particulier dans le district de Subang). Cela nous a permis également de comprendre la situation et les besoins des fermes laitières de la région. En effet, un projet de développement laitier existait de 2007 à 2009 (première période) et de 2011 à 2014 (deuxième période). Au cours de la première période, le projet a fourni du crédit pour l'achat de trois vaches gestantes et des formations pour devenir producteurs laitiers. La population de vaches laitières et de producteurs laitiers a ainsi fortement augmenté. Dans la seconde période, le projet a fourni non seulement du crédit mais aussi une formation aux pratiques d'élevage laitier et à la rénovation de l'étable dans le but d'améliorer les moyens de subsistance des agriculteurs. Cette étude a été réalisée en 2014 dans un des sous-districts (Ciater), comprenant 131 éleveurs coopérateurs. Un échantillon de 61 éleveurs a été constitué. Les données sont issues d'une enquête directe en élevage (2014) et des relevés disponibles auprès de la coopérative, ainsi qu'un diagnostic réalisé en 2010, au lancement de la deuxième phase.

Ensuite une étude a été réalisée pour évaluer la durabilité du système d'élevage laitier (deuxième phase). Avant de commencer l'évaluation, des indicateurs de durabilité ont été construits. Pour cela, la méthode MESMIS a été adaptée pour définir le cadre de l'évaluation et les indicateurs pertinents. Cette méthode a été choisie en raison de

l'approche systémique, ascendante, participative, flexible et multidisciplinaire (López-Ridaura et al., 2002). L'application de ce cadre a permis de sélectionner six indicateurs appropriés dans le contexte local. Une enquête a été réalisée en 2015 auprès de 355 éleveurs dans les districts de Subang et Bandung Barat. Pour les 6 indicateurs retenus, un score de durabilité a été calculé pour chaque exploitation. Puis par des analyses multivariées sur ces scores, des profils de durabilité ont été identifiés, permettant de distinguer des groupes d'exploitations plus ou moins durables. D'autres caractéristiques des exploitations ont ensuite été mises en relation avec ces profils, pour tenter de comprendre les facteurs de cette durabilité.

Enfin, une étude a été menée pour une meilleure compréhension de la dynamique du système d'élevage laitier (troisième phase). Une approche diachronique (analyse de trajectoire) nous a permis de mieux comprendre clairement le contexte local et les moteurs du changement. Une typologie des 355 exploitations a été réalisée, à partir de l'enquête menée en 2015, sur la base de données de structures (main d'œuvre, terre, cheptel) et de combinaison d'activités (utilisation des terres, contribution des activités au revenu). Un échantillon stratifié de 20 exploitations a alors été construit, avec 5 exploitations par type. Des entretiens ont été menés pour établir la trajectoire de ces exploitations depuis leur entrée dans la production laitière. Une analyse transversale a permis de dégager les grands types de trajectoires et d'identifier les facteurs qui expliquent ces trajectoires, ainsi que les raisons qu'en donnent les éleveurs. .

Etape 1

Contexte

Un projet de développement laitier existait depuis 2007 (première période) et de 2011 à 2014 (deuxième période) dans le sous-district de Ciater, district de Subang, dans la province de Java-Ouest. Le projet était une collaboration entre une entreprise privée, une coopérative laitière (Koperasi Peternak Sapi Bandung Utara-KPSBU), une ONG, une université et des parties prenantes locales. L'objectif principal du projet était de développer le secteur laitier dans la région et de stimuler les moyens de subsistance des agriculteurs. Avant 2007, la production laitière n'était pas une activité très développée

dans la zone. Les familles rurales étaient principalement des travailleurs salariés dans une plantation de thé d'État (PTPN).

Objectifs

Cette étude vise à identifier le rôle du projet de développement laitier dans le sous-district de Ciater. Nous cherchons ici à répondre à deux questions.. Premièrement, "quel est le rôle du projet de développement laitier?" ; deuxièmement, "quelle est la situation et les besoins des producteurs laitiers?". Notre hypothèse était que le projet de développement laitier pourrait augmenter les moyens de subsistance des agriculteurs en augmentant leur capital. L'activité laitière reste importante pour les agriculteurs pauvres afin de couvrir les dépenses quotidiennes.

Principaux résultats

Dans la zone d'étude, les producteurs laitiers ont un capital limité. En moyenne, les agriculteurs ont de deux à quatre vaches par exploitation avec moins de 0,3 hectare par exploitation. Le projet de développement laitier existant a joué un rôle clé pour accroître les moyens de subsistance des agriculteurs. Grâce à l'accès accru au crédit et au soutien technique du projet laitier par la formation des producteurs, il a amélioré la performance de la production laitière. Cependant, les activités du projet ne pourraient pas être suffisantes pour développer des fermes laitières durables. Le projet se concentre sur l'augmentation du capital en cheptel et équipement pour l'élevage et la traite. C'était un préalable important, mais il faudrait poursuivre les actions sur l'augmentation d'autres facteurs de production, tels que l'accès à la terre et au fourrage.

Etape 2

nous continuons d'évaluer la durabilité du système d'élevage laitier.

Après avoir compris la situation et les besoins des agriculteurs dans la première étape, nous avons mené une étude pour évaluer la durabilité des systèmes d'élevage laitier. L'étude visait à comprendre la durabilité du système de production laitière et à déterminer pourquoi certains agriculteurs ont une meilleure durabilité, en considérant les différentes dimensions de la durabilité. Pour cela, nous avons travaillé dans deux districts de la

province de Java-Ouest, sur un échantillon de 355 éleveurs. Cela nous a permis d'avoir une vision plus complète, avec des éleveurs à la fois très récemment installés dans l'activité (comme dans le sous-district de Ciater, étape 1), mais également impliqués depuis plus longtemps, de l'ordre d'une trentaine d'année (district de Bandung Barat). Cette étude doit nous permettre de répondre à notre sous-question de recherche: "Quelles sont les conditions du système de production laitière dans la perspective de la durabilité?".

Objectifs

Pour réaliser cette étude, nous avons d'abord cherché à identifier quels sont les indicateurs de durabilité, pertinents localement. A partir de ces indicateurs, nous avons pu identifier différents profils de durabilité, regroupant des exploitations qui ont des scores comparables sur les différents indicateurs. Enfin, en examinant les caractéristiques des exploitations, en termes de structure, de fonctionnement et de résultats techniques et économiques, nous avons cherché à comprendre quels sont les facteurs qui expliquent les différences de durabilité pour les différents indicateurs.

D'après les résultats de la première étape, nous faisons l'hypothèse que les fermes avec un capital plus élevé ont une meilleure durabilité que les autres fermes, en particulier pour la dimension économique et sociale. Les meilleures performances économiques permettraient aussi d'investir dans des innovations pour la gestion des effluents d'élevage.

Résultats

Pour évaluer la durabilité, nous avons identifié un ensemble d'indicateurs, basés sur la revue de la littérature, et sur les entretiens approfondis avec les différentes parties prenantes de l'élevage laitier dans la zone d'étude. Nous avons ensuite sélectionné des indicateurs pertinents, dans les quatre dimensions du développement durable (économique, sociale, environnementale et vulnérabilité) pour évaluer la durabilité dans le site d'étude. Cette sélection a été réalisée à partir d'un classement des indicateurs par les parties prenantes. Nous avons mené une enquête auprès de 355 fermes pour renseigner ces indicateurs ainsi que d'autres variables (structure de l'exploitation, fonctionnement,

en particulier de l'activité laitière, résultats techniques et économiques) pour expliquer pourquoi les fermes sont meilleures dans certaines dimensions.

Nous avons 6 indicateurs pertinents. Dans la dimension économique, nous avons retenu le revenu total par actif familial. Pour la dimension sociale, l'indicateur est la volonté de poursuivre dans l'activité, notamment pour la prochaine génération. Pour la dimension environnementale, le point critique concerne la gestion des effluents d'élevage. Enfin, trois indicateurs sont retenus dans la dimension vulnérabilité, ce qui montre l'importance donnée localement à cette dimension. Ce sont d'une part la dotation en capital, avec le cheptel et le foncier détenu en propriété, et d'autre part la diversification des activités productives. L'étude montre clairement qu'il existe cinq profils de durabilité dans le site d'étude.. Le profil P2 présente des scores de durabilité très faible dans toutes les dimensions, sauf pour la volonté de poursuivre dans l'activité. Les profils P1 et P3 ont des scores faibles de durabilité dans la dimension économique (faible revenu par actif), avec également des scores faibles pour au moins un des indicateurs de la vulnérabilité (peu de capital – cheptel et terre- par actif par exemple pour P1, ou peu de diversité des activités pour P3). Le profil P5 présente en revanche des scores élevés pour tous les indicateurs. Enfin P4, présentent également des scores élevées, sauf pour l'indicateur « diversité des activités ». Le profil 1 (P1) correspondant à des fermes très petites, avec une diversification des sources de revenus.. Le profil 2 (P2) est une petite ferme laitière spécialisée, en difficulté, mais dont les enfants veulent poursuivre dans la production laitière. Dans le profil P3, également spécialisé, la dotation en capital est plus élevée qu'en P2, l'attention à la gestion des effluents est également plus forte, mais les résultats économiques sont également très faibles et les enfants souhaitent peu poursuivre dans l'activité. Le profil 4 (P4) était une ferme laitière spécialisée, avec une dotation en capital supérieur, et une conduite permettant d'obtenir de bons résultats économiques, la spécialisation laitière fragilise tout de même ce profil, le rendant plus vulnérable. Le profil 5 (P5) est une petite ferme diversifiée, obtenant des résultats économiques corrects.

Les principaux enseignements de cette étude sont les suivants. Premièrement, il existe un lien entre la durabilité économique (revenu) et la dotation en capital (cheptel et terre). Une bonne dotation en capital (P4, P5) permet aux familles d'être moins vulnérables mais

aussi de générer des revenus pour assurer la subsistance de la famille. Les familles avec de faibles dotations (P1, P2, P3) ont du mal à dégager un revenu suffisant. Deuxièmement, les exploitations qui diversifient leurs sources de revenus (P1 et P4) présentent une meilleure durabilité. C'est le cas de P4 qui présente le profil le plus équilibré sur les 6 indicateurs, mais aussi de P1 même si les revenus globaux par actif de la famille ne sont pas très élevés, les enfants veulent continuer dans l'activité laitière (durabilité sociale), des pratiques sont mises en œuvre pour la gestion des effluents (durabilité environnementale). Ainsi le niveau de capital et la diversification des revenus de la famille jouent tous deux un rôle important dans la durabilité des exploitations. Des capitaux plus élevés peuvent générer des performances technico-économiques plus élevées et promouvoir une durabilité plus élevée. Pendant ce temps, la diversité des activités peut jouer un rôle clé pour réduire les risques liés aux activités laitières.

Cette étude joue un rôle clé pour comprendre la durabilité des systèmes d'élevage laitier en Indonésie, à partir d'une analyse synchronique, sur un large échantillon. Cependant, pour mieux répondre à la question de recherche de la thèse, une étude plus approfondie est nécessaire notamment pour comprendre la dynamique au niveau des agriculteurs. Le chapitre suivant présente la compréhension des stratégies des agriculteurs dans le développement de la production laitière en Indonésie.

Etape 3

Les études précédentes ont montré l'importance du capital, de l'accès à la formation technique et de la diversification des sources de revenus pour promouvoir un niveau plus élevé de durabilité. Ces résultats ont été obtenus à partir d'analyse instantanées, synchronique (étape 2), soit à partir d'une analyse dynamique de court-terme (comparaison 2010-2014, pour l'étape 1). Pour compléter ma réponse à notre question de recherche: «dans quelle condition les petites exploitations agricoles seront-elles durables dans le futur?», nous avons mené une dernière étude pour travailler sur les dynamiques à plus long terme.

Cette étape 3 est donc une étude dynamique; au niveau des agriculteurs. L'étude visait à comprendre les stratégies et les moteurs des agriculteurs pour faire face à leurs limites. Cela nous permet également d'identifier les changements dans les systèmes de production de lait en Indonésie, et de comprendre les stratégies des agriculteurs pour le développement de la production laitière. Il est important de faire une telle réflexion sur le modèle agricole dans le développement laitier national.

Objectifs

Le premier objectif de cette étude est les trajectoires des exploitations agricoles, en termes notamment de développement de la production laitière dans les exploitations. L'analyse des ces trajectoires doit alors nous permettre d'apprécier les dynamiques et les moteurs du changement dans les systèmes d'élevage laitier en Indonésie.

Les études précédentes ont montré l'importance de la dotation en capital et de la diversification des activités. Nous avons alors réalisé une typologie des 355 exploitations, à partir des données de l'enquête réalisée pour la deuxième étape. Nous avons alors sélectionné un échantillon de 20 agriculteurs comme représentants chaque type d'élevage. Nous avons ensuite effectué une analyse de trajectoire pour ces agriculteurs sélectionnés. Nous faisons l'hypothèse qu'il y a des stratégies différentes pour chaque type d'élevage et que l'analyse diachronique, sur le long terme, va nous permettre de confirmer les résultats de l'étude synchronique. L'analyse des changements et de leur moteur est aussi une façon pertinente de considérer l'impact de ces dynamiques laitières, à l'échelle des élevages, sur le développement du secteur laitier national

Résultats

Nous avons tout d'abord réalisé une typologie des élevages, à l'aide d'analyses multivariées, en distinguant quatre types, selon leur structures (cheptel et accès à la terre) et leur combinaison d'activités (élevage, cultures, activités en dehors de l'exploitation). Nous avons alors comparé les performances techniques et économiques de chaque type de ferme, sur la base des résultats de l'année 2015. Enfin, pour 20 élevages, répartis de façon équilibrée entre les 4 types, nous avons retracé leur histoire depuis le démarrage de l'activité laitière ou la reprise de l'exploitation par le chef actuel. A partir de ces 20 cas,

nous avons identifié des dynamiques (agrandissement des facteurs de production, abandon ou reprise d'activités) et caractériser 3 grands types de trajectoires d'exploitation.

Chaque type de ferme montre différentes stratégies pour assurer un revenu familial durable. Ces stratégies ont diverses répercussions sur la fourniture de lait au marché national et sur le développement de la production laitière nationale.

Les exploitations disposant d'un capital limité ne sont pas en mesure d'augmenter leur cheptel et d'améliorer leur contribution au développement de l'offre nationale de lait. Pour faire face à leurs limites en termes d'actifs agricoles, certaines fermes mènent des activités extra- agricoles. Les raisons principales expliquant leur difficulté à augmenter la production de lait sont liées à leurs contraintes d'accès aux moyens de production (foncier, main-d'œuvre et ressources financières) et aux risques auxquels ils sont confrontés.

Les systèmes mixtes culture-élevage restent stables en termes de production laitière car ils gèrent de manière optimale les ressources pour deux activités. Nous n'avons pas observé d'abandon des cultures, ni d'éleveurs spécialisés en production laitières qui auraient développé une activité de production végétale (les familles qui sont aujourd'hui en système mixtes sont toujours restées dans ces systèmes mixtes). Les fermes spécialisées à fort capital ont augmenté rapidement la taille de leur troupeau. Ce type a contribué à un niveau plus élevé à l'augmentation de la production nationale. À l'avenir, ce type pourrait jouer un rôle important dans le développement de la production laitière en Indonésie. Ce type spécialisé est plus vulnérable que le type mixte précédent, mais son niveau de capitalisation est aussi un facteur de réduction de la vulnérabilité.

Ces deux types de petites exploitations laitières familiales montrent que l'activité laitière peut effectivement contribuer au développement durable en Indonésie, à la fois en assurant les revenus de ces familles rurales, de façon relativement sécurisée, et en contribuant à la sécurité alimentaire au niveau national, en fournissant le marché national en lait local.

Ce chapitre montre clairement l'importance des stratégies de dotation en capital et de diversification sur la durabilité du système de production laitière en Indonésie. Il fournit une approche dynamique qui est importante pour comprendre les stratégies des fermes pour assurer le revenu familial. La section suivante présente les principales conclusions et les stratégies politiques pertinentes.

Conclusion

La thèse visait à comprendre dans quelles conditions les petites exploitations laitières seront durables à l'avenir. Les petites exploitations sont confrontées à de nombreux défis tels que la pénurie de capitaux, l'accès à des ressources naturelles de bonne qualité (sols et eau), des conditions climatiques incertaines et des risques économiques. Dans ce contexte, l'élevage laitier apparaît comme une activité permettant de générer des revenus élevés par unité de surface cultivée, et semble ainsi constituer une activité intéressante pour garantir les moyens de subsistance des petits exploitants ruraux. Mais les risques associés à cet élevage nécessitent de bien évaluer « dans quelles conditions les petites exploitations laitières seront-elles viables à l'avenir ».

Le premier chapitre a traité de la situation et des besoins des fermes laitières dans un petit sous-district de la province de Java-Ouest. Cela a permis de comprendre le rôle d'un projet de développement laitier. Dans ce district, comme dans le reste du pays, les petites exploitations laitières ont un capital limité. En moyenne, les agriculteurs n'ont que trois vaches par exploitation avec moins de 0,3 hectare. Le projet de développement laitier que nous avons étudié a joué un rôle clé dans l'augmentation des moyens de subsistance des agriculteurs. En soutenant l'accès au crédit et l'appui technique pour les agriculteurs, le projet laitier a amélioré la performance des unités de production laitière. Le projet s'est concentré sur l'augmentation du capital et du savoir-faire avec un certain succès. Cependant, les activités du projet ont dû cesser et elles n'étaient pas suffisantes pour développer des fermes laitières à un niveau élevé de durabilité. Il aurait dû être suivi de certaines activités pour sécuriser les principaux facteurs de production tels que la terre et le fourrage. Ce chapitre était une première étape pour répondre à notre question de recherche.

Pour mieux répondre à notre question de recherche, nous avons mené au chapitre deux une évaluation de la durabilité des petites exploitations laitières. Les fermes les plus durables étaient celles qui avaient un capital plus élevé et une activité diversifiée (modèle 5). Les fermes à faible capital qui pourraient développer une activité supplémentaire (modèle 1) étaient plus durables que les fermes spécialisées (modèles 2 et 3). La dotation en capital et le niveau de diversification des activités à la ferme jouent un rôle important dans la durabilité des exploitations. Les exploitations à capital plus élevé peuvent générer des performances technico-économiques plus élevées et promouvoir une durabilité plus élevée. La diversité peut aider à réduire les risques associés aux activités laitières.

Le troisième chapitre a clairement identifié des résultats importants pour répondre à notre question : il nous a permis de mieux comprendre la dynamique des systèmes de production laitière en Indonésie. Chaque type de ferme met en oeuvre différentes stratégies pour assurer le revenu familial et fournir du lait au marché national. Les fermes à dotation limitée en capital peuvent difficilement contribuer davantage au développement de la production laitière en Indonésie. Pour faire face aux diverses contraintes, certaines de ces fermes se diversifient en développement des activités agricoles. Les systèmes mixtes culture-élevage restent stables en termes de production laitière car ils gèrent de manière optimale les ressources pour deux activités. Les fermes spécialisées à fort capital ont augmenté rapidement la taille de leur troupeau. Ce type a davantage contribué à l'essor de la production nationale. Selon ces résultats, ce type de fermes pourrait jouer un rôle important dans le développement de la production laitière en Indonésie dans les années qui viennent.

À partir de ces trois chapitres, nous avons conclu que les agriculteurs ayant un capital plus élevé et une activité diversifiée présentaient de meilleures performances de durabilité que les agriculteurs spécialisés. Les fermes spécialisées vont très certainement jouer à l'avenir un rôle clé pour soutenir la production nationale en raison de leur capacité à augmenter rapidement son cheptel laitier. Mais ces fermes spécialisées pourraient être moins durables que les fermes diversifiées. De ce fait, se concentrer uniquement sur les fermes spécialisées pour stimuler l'offre de lait domestique ne nous semble pas pertinent.

Il convient aussi d'accompagner les plus petites exploitations dans des trajectoires d'évolution plus durables.

En effet, en raison de leur nombre élevé, les petites exploitations sont importantes pour l'approvisionnement national en lait et elles sont également importantes pour réduire la pauvreté, créer des emplois et assurer la nutrition des familles rurales. À l'avenir, les politiques laitières devraient mettre davantage l'accent sur les formations et les programmes de crédit des très petits exploitants. Plus généralement, les programmes politiques devraient adapter leurs stratégies à chaque type d'exploitation, afin de mieux soutenir la transition des exploitations vers un développement durable du secteur laitier.

GENERAL INTRODUCTION

1. Dairy sector in Indonesia

1.1 The History of dairy sector

Historically, the consumption of milk products is quite recent in South-East Asia, whereas in other parts of the world, milk has long been an important part of the diet of many pastoral and agro-pastoral communities. Practices of milking female ruminants (mainly cows, but also goats, ewes, camels, mares) seem to originate from the Middle East and they spread in the Mediterranean Basin, Europe, Indian subcontinent, West and East Africa, and South and Central America (Moran, 2005). In South East Asia, despite cattle, goats and buffaloes were raised for traction and for meat, milk had not been consumed before the end of the 19th century.

In Indonesia, dairy production started at the end of the 19th century. During the Dutch colonial period (before 1942), the dairy production was developed by the Dutch Government who imported 150 Friesian Holland bulls from the Netherlands (1891-1893). Before that, Airshire, Milking shorthorn, and Jersey cows had already been imported from Australia. And Holstein Friesian dairy cows had already been mated with local breeds in Pasuruan, East Java (Subandriyo and Adiarto, 2009). The aim was to meet the demand of dairy products for Dutch workers in particular (Nurtini and Muzayyanah, 2014; Subandriyo and Adiarto, 2009).

Dairy animals were mainly raised in Java Island. Dairy cattle breeding started in the beginning of the 20th century from the mountain area in Central Java (Boyolali, Salatiga, and Ambarawa). It was then extended to West Java (Bandung area) and in East Java (Nongkojajar, Malang and Batu). The dairy cattle population was mainly managed by Dutch enterprises. However, in Jakarta and in the surrounding area, there were also local dairy producers (Subandriyo and Adiarto, 2009). The situation was difficult for local producers: since they had to manage dairy cattle traditionally, the production of milk was of low quality and quantity. The strict regulation from the Dutch made it difficult for local producers to develop.

Under the Japanese occupation (1942-1945) and during the national revolution (1945-1949), the dairy sector was in an emergency situation. The country had to face severe

conflicts and economic difficulties. Milk production was drastically reduced and the concentrate was very expensive and often unaccessible (Subandriyo and Adiarto, 2009). Some dairy farms were simply abandoned. Consequently, many dairy cattle were slaughtered and some others were distributed to the local farmers. It was a starting point of the emergence of smallholder dairy farmers (Nurtini and Muzayyanah, 2014; Subandriyo and Adiarto, 2009).

During the rehabilitation period (1949-1956) characterized by a parliamentary democratic with Sukarno as a leader, food sector was the priority. Developing agriculture and livestock sector (including the dairy sector) was the main concern (Nurtini and Muzayyanah, 2014; Subandriyo and Adiarto, 2009). In this period, government's efforts aimed at recovering dairy sector through increasing calving rate, decreasing illegal slaughtering, and promoting milk consumption (Subandriyo and Adiarto, 2009).

During the « guided democratic » period (1957-1966) that was the second period of president Sukarno's leadership, the government focused on restoring the authority of village elders and government authority. Increasing the food production and adjust it with the purchasing power became the main priority. Dasuki (1983) reported that the target for dairy production was to increase 7.9 percent of milk production per year. However, the political situation was not conducive, the economy was dramatically unstable, and the government did not implement that target.

In the « New order » era ruled by general Suharto (1966-1998), the country benefited from large scale public investments programmed in five-years plans ("REPELITA"). The Suharto regime also developed social engineering projects designed to transform Indonesian society towards "development". The first REPELITA (1969-1974) focused on agricultural improvement to ensure food security. As a consequence, agricultural sector gradually improved (Nurtini and Muzayyanah, 2014; Subandriyo and Adiarto, 2009). In the dairy sector, policy programs were designed to increase the population of cattle, improve farmers' productivity, and support national production in order to meet national demand. In particular, credit schemes were designed to support farmers' engagement to buy dairy cows, and processing companies were asked to collect available local milk.

This efforts resulted in a « development period » for the dairy sector from 1966 to 1980, and in a “dairy herd increase period” from 1980 to 1997 (Sudaryanto and Hermawan, 2014).

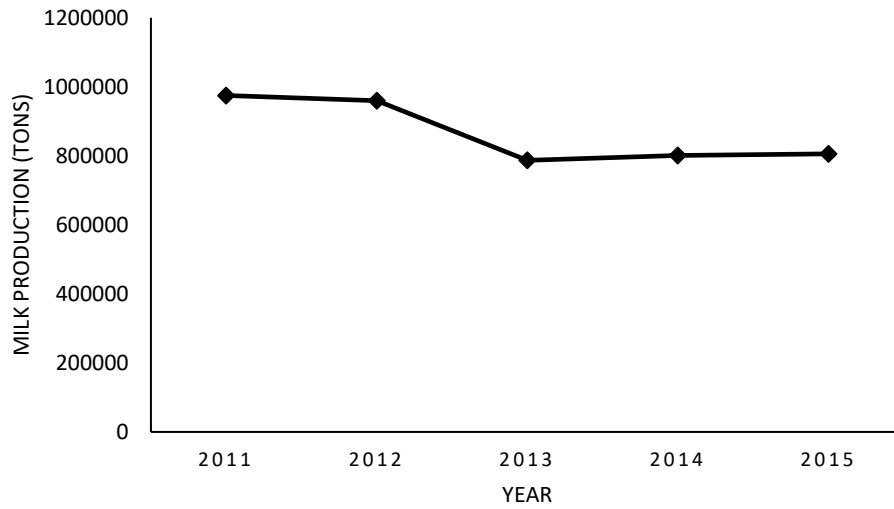
After the 1997 Asian financial crisis and the downfall of the Suharto regime (1998) started the « stagnancy period » (Sudaryanto and Hermawan (2014)). This period was heavily influenced by the economic and political crisis in 1998. In addition, government issued decree no.4/1998 about removing local milk ratios due to international pressure (adhesion to WTO in 1995 and free trade agreements). In other words, the tariff protection was lowered in disfavour of local producers.

1.1.1 The role of import in the dairy development policies

In South East Asia, the high population growth and changes in eating habits have strongly influenced the rise of the demand for dairy products (Moran, 2005). Rapid economic growth and awareness to consume nutritious food became important factors that boosted milk consumption. Between 1990 and 2013, the consumption of dairy product per capita in Indonesia increased from 4 to 13 kg of milk equivalent (FAO, 2017). Even though, it remains relatively low compared to other ASEAN countries, the demand of dairy product could not be covered by national production. The national production accounted for only around 835.000 tons (Figure 1) in 2015. The rise of dairy imports became the solution to meet the demand.

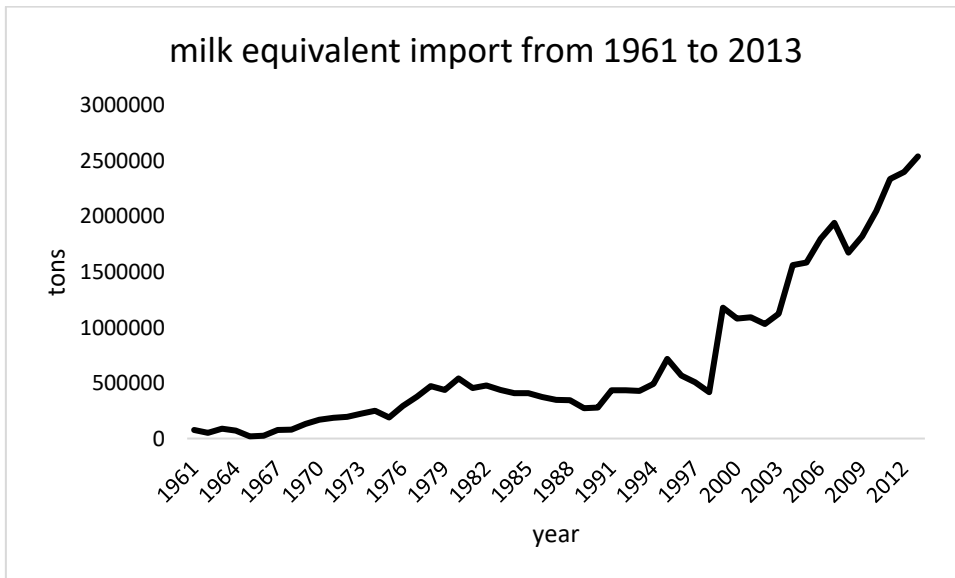
Dairy imports play a key role in the dairy sector in Indonesia. In particular, due to the rising demand and the liberalization policies, the trend in milk imports started to rise sharply half decade ago (Figure 2). In 2012, the quantity of milk import reached 2.4 millions tons milk equivalent (FAO, 2017).

Figure 1 milk production in Indonesia from 2011 to 2015



Source: Badan Pusat Statistik (2016); *Direktorat Jenderal Peternakan dan Kesehatan Hewan-Ditjen PKH* (2016)

Figure 2 Import of dairy product from 1961 to 2012



Source: FAO (2017)

Table 1 Consumption of dairy product in Indonesia from 2009 to 2014

Product	Unit	2009	2010	2011	2012	2013	2014
Fresh milk	Liter/capita/week	0.002	0.002	0.003	0.003	0.002	0.003
Preserved milk	250 ml/capita/week	0.016	0.018	0.022	0.028	0.028	0.031
Sweet canned liquid milk	397 gram/capita/week	0.058	0.064	0.063	0.052	0.058	0.059
Canned powder milk	Kg/capita/week	0.014	0.015	0.014	0.007	0.014	0.015
Infant powder milk	400 g/capita/week	0.023	0.023	0.026	0.027	0.027	0.028
Cheese	Ounce/capita/week	0.001	0.001	0.002	0.002	0.001	0.002
Other dairy product	Ounce/capita/week	0.006	0.007	0.007	0.008	0.004	0.006

Source: Badan Pusat Statistik (2016); Ditjen PKH (2016)

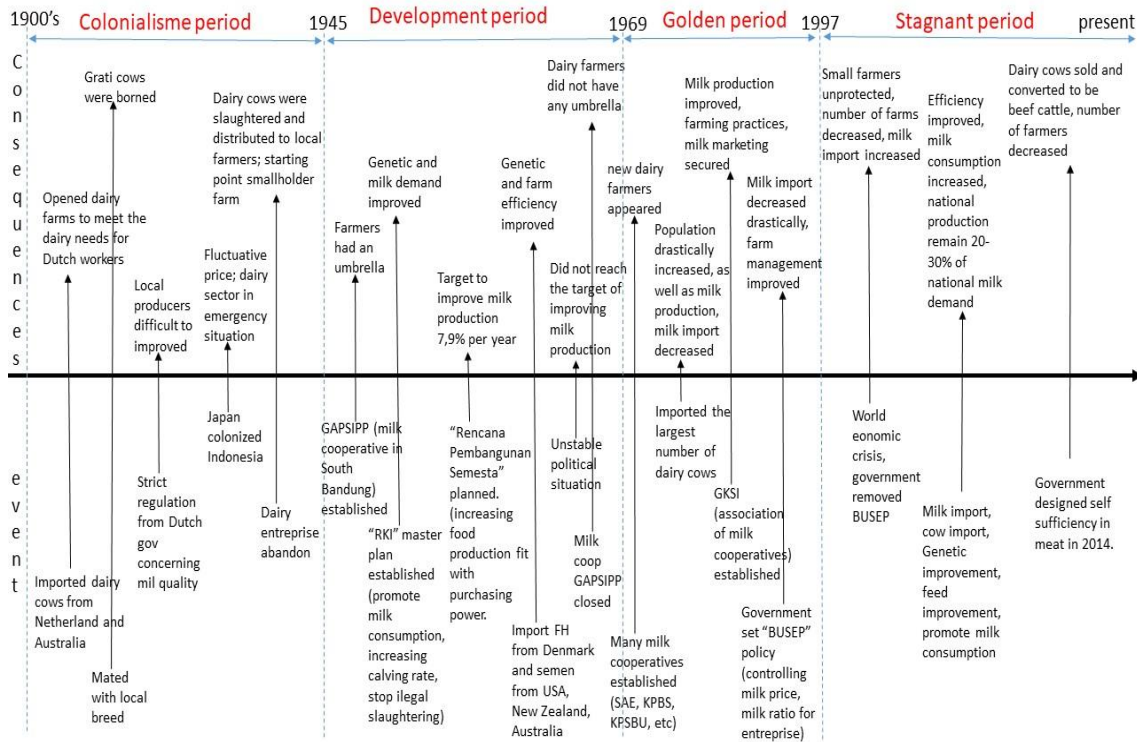
In the « development period » (1966 to 1980), the government imported cows mainly for genetic improvement. Totally, more than one thousand “Friesian Holland” cows were imported from Denmark in 1962. Two years later, more than 1300 cows were again imported (Subandriyo and Adiarto, 2009). Previously, another breed (Red Danish) was tested for milk production in Indonesia. But this breed were not well adapted to local conditions (Subandriyo and Adiarto, 2009). In addition to dairy animals of high quality breeds, frozen semen was also imported from New Zealand, Australia and United States of America to improve the genetic potential of the local herd for milk production (Subandriyo and Adiarto, 2009).

In the « dairy herd increase period” (1980-1997), previous import policies were further developed. This period was a golden period for the Indonesian dairy sector. The government focused on enhancing the dairy herd, providing credit to farmers, improving quality of the cows, and improving the management. More than 125 thousands cows were imported in the beginning of the 1980’s. The dairy herd almost tripled (Sudaryanto and Hermawan, 2014). In 1985, the Presidential instruction no. 2/1985 was issued to boost dairy farmers and to improve milk consumption with the appropriate price. The government controlled milk prices from the farmers level until the consumers level and set local milk ratios for dairy industry. Based on this policy, dairy industry had to purchased the local milk as main ingredients and the rest came from importation. Consequently, the ratio of milk import to local milk was drastically reduced from 20:1 to 3.5: 1 (Tawaf et al., 2009) or even 2:1 (Subandriyo and Adiarto, 2009; Sudaryanto and

Hermawan, 2014). This policy was also well-known as “*Bukti Serap (BUSEP)*” : import was restricted to the companies that had an « absorption certificate » (*Bukti Serap*) for having absorbed the available local milk in their factory (Nugroho, 2010; Sudaryanto and Hermawan, 2014). In term of improving the quality of cows, a center of artificial insemination was created in Lembang (Subandriyo and Adiarto, 2009). High quality semen was produced and led to less dependency on genetic imports. The Government also focused on improving the management practices and knowledge. Based on the presidential instruction in 1985, dairy-related sector were led by the Minister of Agriculture and helped by the Minister of Development of Animal Husbandry and Fisheries Products that had been recently created, together with the related ministries.

The golden era of the dairy sector met a turning point in 1997-1998. World economic crisis in that year impacted negatively almost all sectors including the dairy sector (Sudaryanto and Hermawan, 2014). The situation was aggravated by the presidential instruction no.4/1998. Due to international pressure, government removed local milk ratio which led to reduced farmers’ protection. Milk industry had no more obligation to absorb local milk. Local producers had to compete with imported dairy product.

Figure 3 The history of dairy sector in Indonesia



Source: Nurtini and Muzayyanah (2014); and Subandriyo and Adiarto (2009)

1.1.2 The role of cooperative

In Indonesia, milk cooperatives have played a central role to boost dairy production, to enhance the livelihood of dairy farmer and to improve the economic growth in rural area (Subandriyo and Adiarto, 2009). In the history, cooperatives and private collectors had direct relationships with farmers in the dairy marketing channels. But progressively, farmer created groups of farmer. And the groups of farmers then joined other groups, together to build dairy cooperatives (Tawaf et al., 2009).

In 1949 a dairy cooperative named *Gabungan Petani Peternak Sapi Perah Pangalengan-GAPSSIP* was created in the south of Bandung (West Java Province). It was the first dairy cooperative in Indonesia. However, in 1963, GAPSSIP was closed, due to the unconducive economic-political situation and the increasing of milk industry. In 1969, the milk producers cooperative in South Bandung (*Koperasi Peternak Bandung Selatan-KPBS*) was created and replaced GAPSSIP. Two years later, in 1971, the North Bandung milk producers cooperative (*Koperasi Peternak Sapi Bandung Utara-KPSBU*) was

established (unpublished data-KPSBU, 2012). In East Java Province, *SAE Pujon* was founded in 1962 (Sulastrri and Maharjan, 2002). It then followed by other milk cooperative included *KUD Batu*, *Koperasi Setiakawan*, and *Koperasi Sukamakmur* (Subandriyo and Adiarto, 2009). In 1978, there were 11 milk cooperatives with 2800 members, in total (Nurtini and Muzayyanah, 2014).

At a national level, the Federation of dairy cooperatives (*Gabungan Koperasi Susu Indonesia-GKSI*) was created in 1980. The initial members were 17 dairy cooperatives. Its role was to enhance the communication among members and to build supporting system for dairy business in Indonesia (Subandriyo and Adiarto, 2009). Furthermore, several collective services such as cow supply, milk marketing, training, feed production and supply, vet services, and technical support were also provided by GKSI (Sulastrri and Maharjan, 2002).

Between 1980 and 1997, the government issued policies to support dairy sector and dairy cooperatives. . New farmers were enthusiastic to start a dairy business. of the number of milk cooperatives drastically increased (accounted for almost 20 times more) (Subandriyo and Adiarto, 2009; Sudaryanto and Hermawan, 2014). They had an important role to boost dairy production, to improve milk quality and to increase cow populations.

In West Java, a « secondary cooperative” “GKSI Jawa Barat” was established in 2000. There were 22 primary cooperative as member including KPSBU and KPBS Pengalengan. The aims were to coordinate, to monitor and to evaluate the members. In addition, the activities conducted to the members were training of dairy farming practices, processing milk, enhancing milk quality and cow population. GKSI Jawa Barat built a milk processing (PT ISAM). It could absorb for around 10 percent of fresh milk produced in West Java (<http://gksi-jawabarat.co.id/>).

The main roles of the cooperatives were to provide services to the members (credit, vet service, feed supply, etc.) and to improve farmer’s know-how on dairy practices (Nurtini and Muzayyanah, 2014; Sulastrri and Maharjan, 2002). The objective of the cooperative model was to improve the livelihood of small farmers by collective action. Even with

those successes, the role of cooperatives still needed to be improved. Tawaf et al. (2009) indicated that four strategic option could be followed to develop dairy cooperatives : a) maximizing potential resources to catch market opportunity; b) improving human resources to get economic efficiency; c) enhancing profesionalism in term of asset management and collaboration among cooperative; and d) increasing services to the members. Cooperative in particular were able to improve the bargaining position of farmers in front of the dairy industry.

1.2 The contribution of the dairy sector to the national economy

Indonesia had a rapid economic growth, which on average is more than 5% per year from 2011 to 2014 (Ditjen PKH, 2016). Agricultural sector played an important role in this economic growth. Ditjen PKH (2016) reported that in 2015, agriculture, fisheries, and forestry sector contibuted to 13.5 percent to the total GDP. Livestock sector in particular was important : it accounted for around 15 percent of agricultural GDP (Badan Pusat Statistik, 2016; Ditjen PKH, 2016). In addition, this share has been increasing : between 2011 and 2015, the livestock sub-sector GDP increased by more than 56 percent (Ditjen PKH, 2016).

The 3 main provinces in terms of livestock production value were East Java Province, DKI Jakarta and West Java Province. Those 3 provinces totally accounted for around 47 percent of the total livestock GDP. The livestock sector generated around IDR 167 trillion in 2014 (Ditjen PKH, 2016).

The agricultural sector is also very important in terms of employment. Among all sectors, agriculture is the one that employs the highest population, with more than 40 million workers involved in agriculture (Ditjen PKH, 2016). The livestock sector contributes to 10 percent of total employment in the agricultural sector with the majority being unpaid workers (family labor). Ditjen PKH (2016) reported that from 2013 to 2015, the number of workers involved in agriculture decreased for around 10 percent.

The livestock sector is important for economic development, enhancing rural livelihoods, poverty alleviation and nutrition (Moran, 2009). Throughout the world, livestock

contributes for more than half the value of agricultural output. Furthermore, thanks to the synergies generated by crop-livestock integration, livestock sector played a role to enhance rural livelihoods.

The dairy sector has become a good activity to generate income for crop farmers in South and East Asia (Moran, 2009). As a result, crop farmers can get better income and even savings when they engage in small-scale dairy farming. Furthermore, dairy business is one of the activities providing the fastest returns for livestock sector in developing countries (Moran, 2009). In Indonesia, in particular, dairying offers a good economic potential. It accounted for around 518 thousands cows in 2015, and produced 835 thousands tons of milk (Ditjen PKH, 2016).

There are two types of milk producers in Indonesia : dairy enterprises and smallholder dairy farmers. Badan Pusat Statistik (2015) reported that there were 35 dairy enterprises in 2015. Smallholder farms hold more than 90 percent of total population of dairy cattle in 2013 (Badan Pusat Statistik, 2013). Both were important to enhance rural income and to meet the needs of the rapid growing urban populations (Moran, 2009).

The dairy enterprises are very dynamic. They employ around 1300 workers (Badan Pusat Statistik, 2015). They are mostly (65 percent) located in East Java and West Java Province. Their production performances are higher than those of smallholder farms. With a dairy cattle herd of 18,500 cows in 2015 (3,6% of the total herd), the commercial dairy enterprises produced around 70,700 tons (8,5% of the production). The productivity per milking cow is 16,4 liters/day. In term of economic performance, they generated IDR 431 billion of total income in 2015, a 22% increase compared to 2013 (Badan Pusat Statistik, 2015).

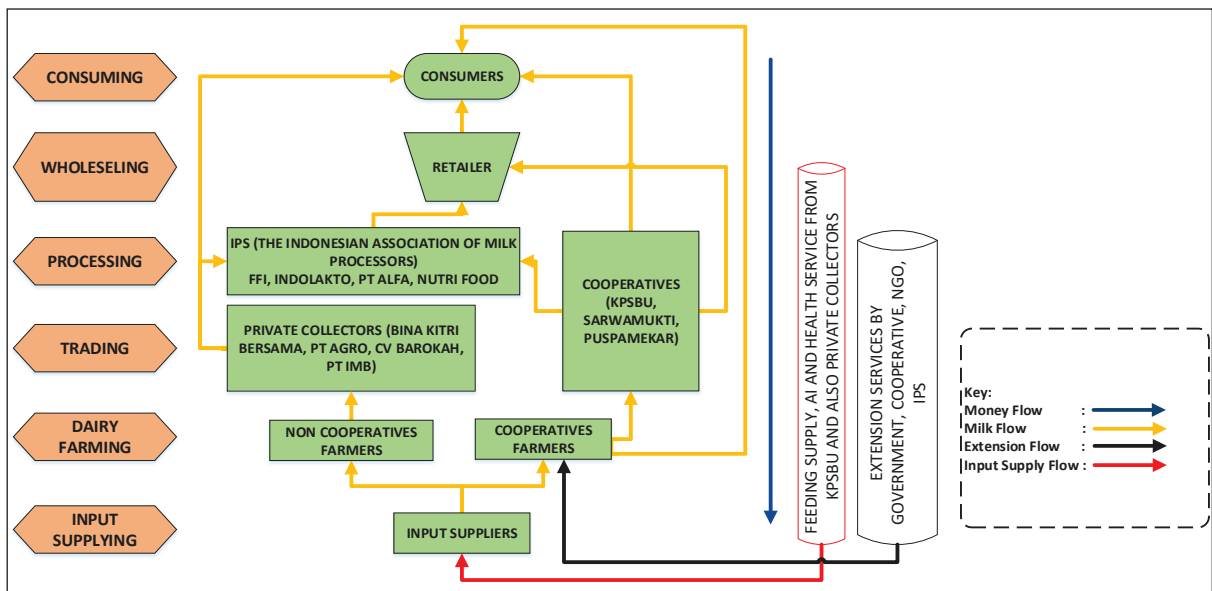
1.3 Dairy marketing

Milk is marketed through different channells (Moran, 2009). A dairy value chain is defined as a sucession of stages followed by milk and dairy products from farmers (producers) to consumers. Milk marketing chains can be divided into two groups: informal marketing chains which are usually small scale and involving few actors; and

formal marketing chains which are medium to large scale, involving more actors, and where the milk is processed into the final products. In the reality, those 2 types of marketing channels are often very much linked to one another, and even sometimes mixed together. In Indonesia, milk trading systems are divided into 3 main models (Tawaf et al., 2009), as below:

1. Farmer – group of farmers – milk cooperative – milk industry (West Java and East Java)
2. Farmer – private collector – milk cooperative – milk industry (Central Java and Yogyakarta)
3. Farmer – private collector – milk industry (Central Java and Yogyakarta)

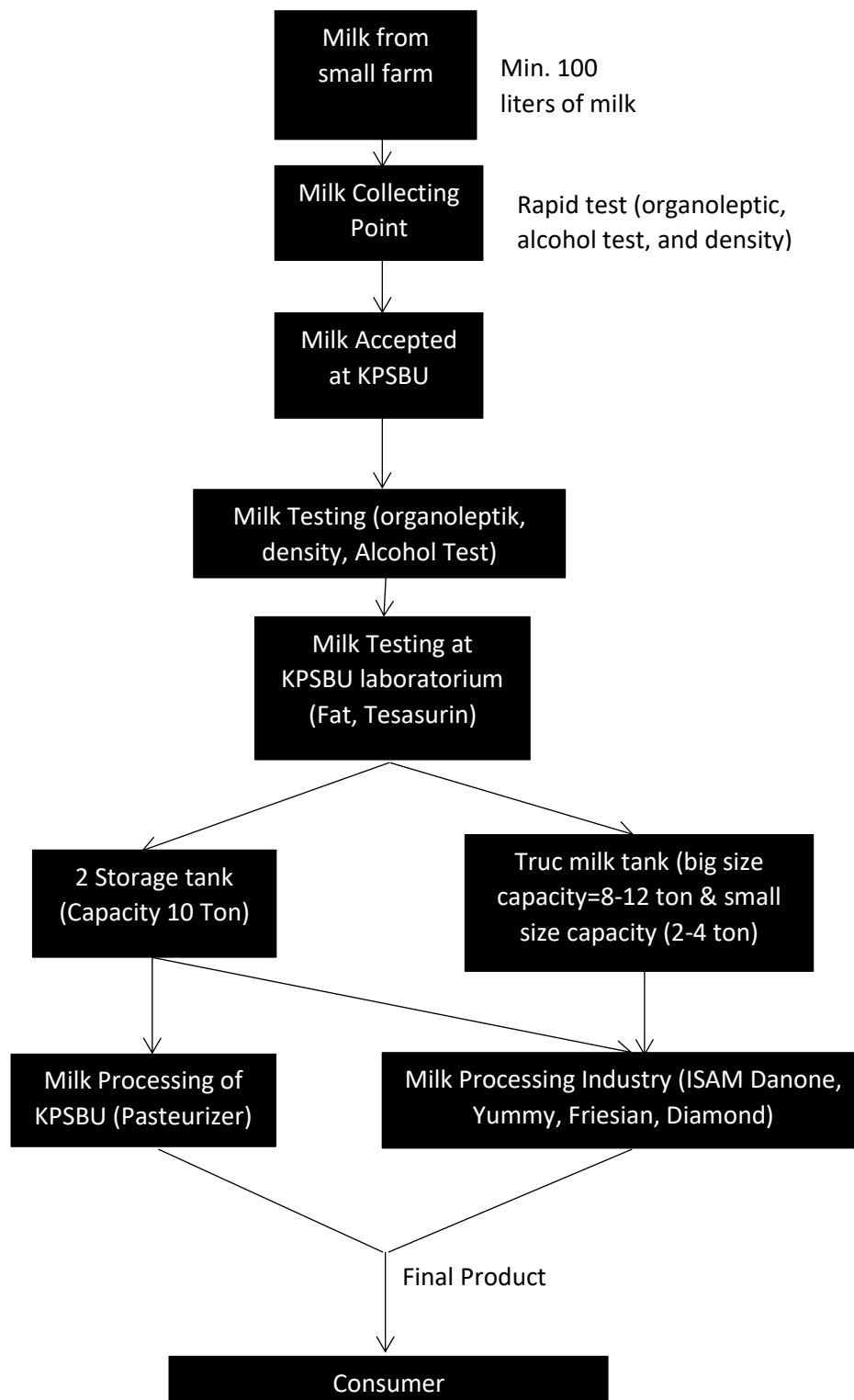
Figure 4 Map of value chain in Ciater (West Java Province) (Source: Duteurtre, et al., 2016)



In West Java (in particular Ciater area), Duteurtre et al (2016) reported that there are two main models in the dairy supply chain, including cooperative and non cooperative models (Figure 4). In term of milk flows, milk from dairy farms are distributed to cooperative. Then, milk is stored and sold to dairy industries and processed into final products. The final products are distributed to the retailers and or directly to the consumers. In addition, the cooperative system, for instance KPSBU sometimes process itself the final products such as pasteurized milk and yogurt that can be sold directly to the retailers or to the consumers. In the other side, non-cooperative farmers sell the milk to the private

collectors. The milk is then stored and sold to the dairy industries to be processed as final product. Tawaf et al., (2009) mentioned that non-cooperative model is developed due to the inaction of dairy cooperatives in the surrounding area. They might be also an extension from dairy enterprises.

Figure 5 Milk flow from farmers to consumers in West Java (KPSBU cooperative)
(Source: CIRAD survey, 2014)



Small-scale dairy farmers in Ciater and Lembang (West Java Province) have many similarities. First, most of the farmers in the region are members of the cooperative KPSBU. KPSBU members receive many services from the cooperative. These services consist of animal health service, AI (Artificial Insemination) service, concentrate feed, milk sales, saving money and loans. KPSBU also provide training for farmers to improve their skills in dairy farming practices.

As member of KPSBU, farmers have to sell the milk to KPSBU. Figure 5 presents the milk flowing process from farmers to KPSBU. There is only a small share of the milk production that is kept for family consumption and calves feeding. The rest is sold to the cooperative. Twice a day, farmers go to milk collecting point (TPK) to sell the milk (Figure 6). There are about 10 to 20 farmers groups called TPS (*Tempat Penampungan Susu*) in each milk collecting point (Figure 7). There are around ten farmers on average per TPS who are selling their milk at the same price. Each group of farmer sells the milk to the KPSBU at a fixed price based on a milk analysis which is done randomly by the KPSBU at the TPS level (Figure 8). Daily milk tests consists of organoleptic test, alcohol test, bacterial count (Total Plate Count - TPC), antibiotic residues, total solid, fat and protein content, and density. KPSBU staff record the quantity of milk sold by each farmer in all TPS. Milk is transported to KPBSU by cooling truck (Figure 9 and 10). At KPSBU, other staff receives the milk to be tested and to be stored in the cooling tank (Figure 11). Milk price depends on the milk quality of each TPS (the price calculation considers freezing point, total solid, and TPC). Usually this test is randomly carried out four times per 15 days.

Figure 6 Farmers delivery milk to milk collecting point by walking (a) or motorcycle (b)



(a)

(b)

Figure 7 Farmers are at milk collecting point



Figure 8 Cooperative staff carry out a milk rapid test



Figure 9 Cooling truck to transport milk from farmers to KPSBU



Figure 10 Cooling trucks arrive at KPSBU



Figure 11 KPSBU staff is preparing to store the milk in the cooling tank



Figure 12 Delivery truck to transport dairy product from KPSBU



After collecting milk from farmers, KPSBU sells the fresh milk to the dairy processing enterprises (e.g. Friesian Flag, Yummy, and Diamond). KPSBU also has small processor unit to process from the fresh milk to pasteurized milk, yogurt, fermented milk, and “krupuk susu” (crackers from milk). There is about 1% of milk transformed in their small processor and to be sold to shops or retailer and consumer directly (Figure 12).

Besides member of KPSBU, in Ciater and Lembang there are also some farmers who sell the milk to private collector. The farmers receive services from private collectors such as AI service and animal health services. However, there are also farmers who use the services from private inseminator for AI service and vets. Similar with KPSBU, Semen for Artificial Insemination are obtained from Artificial Insemination Center (BBIB) Lembang and Singosari (belong to the Ministry of Agriculture). Concentrate feed is obtained from private feed companies. After receive some services, consequently dairy farmers have to sell milk to private collector. Fresh milk is obtained from farmers and then to be sold to dairy processors. Most of milk are sold directly to the consumer, retailer or shop.

In the presence of milk market through cooperative, farmers can easily sell the dairy product. In addition, they can access the production factors such as concentrate, equipments, vet services, or even credit. However, as a price taker, they face some risks such as fluctuation of input price and milk price to set their farm sustainable in the future.

1.4 Current policies and strategies

The Blue Print of Dairy 2013-2025 is the reference document for the national dairy policy (Kemenko Perekonomian Republik Indonesia, 2014). The document aims at coordinating the national policy in the dairy sector. It is supported operationally by each related ministries, stakeholders, farmers, associations, and others. This document also aims at supporting farmers and dairy industries to manage and to improve integrated and sustainable dairy business.

The vision of dairy development in 2025 is to provide sufficient, accessible, and sustainable dairy-based food. To implement this vision, government sets five missions: (i) to make dairy product as a strategic food commodity ; (ii) to boost dairy consumption at family level ; (iii) to promote dairy business in underdeveloped region ; (iv) to support dairy sheds as centers of new economic development ; (v) to improve the capacity of human resources and organization in dairy sector.

The dairy development policy aims at increasing milk supply to meet the national milk demand. Another goal is to promote milk consumption to reach 30 liters per capita per year. In addition, this policy expects to improve farmers' knowledge and skills, to boost the capacity of milk industry, and to open center of new economic development in rural areas. To reach those goals, government set some targets to be implemented. First is to increase the dairy cow population, its production and its productivity. Second is to improve milk consumption. In addition, the targets are to develop milk processing industry from micro until medium scale and to maximize the use of by products as biogas, biourine, biofuel, and fertilizers. Those targets then will be able to improve farmers' livelihood.

The national policy also aims at promoting sustainable dairy development. It focuses on developing the dairy sector for economic reasons, but also for social and environmental

objectives. However, the national policy should elaborate what relevant indicators of sustainability. Our result could be used to indicate and to promote sustainable dairy farms and to characterize which type of farm can contribute to the dairy development in Indonesia.

2. The importance of smallholder farm

2.1 Role of smallholder farm to support national production

In many developing countries of Asia, Sub-Saharan Africa, and Latin America, smallholder farm plays an important role. In Asia for instance, Moran, (2009) mentioned that smallholder dairy business represents potential income generator. It can provide regular income to farmers. Smallholder dairy farmers convert low value forages and crop residues to be high value product (Moran, 2005).

Altieri et al., (2008) defined smallholder farmers as small-scale farmers which are characterized by using mainly family workers, traditional system, and low-resource agriculture for their production as well as using part of product for family consumption. Furthermore, Moran (2009) divided dairy farms into three categories based on their scale, including smallholder (up to 20 milking cows plus replacement heifers), semi-commercial (20-50 milking cows plus replacement heifers), and commercial (more than 50 plus replacement heifers). In Indonesia, Minister of Agriculture through decree No. 404/Kpts/OT.210/2002 mentioned that smallholder farm is a side business activity which is characterized by small-scale farm with a maximum size differently according to their animals (for instance, the maximum is 20 cows for dairy farm).

In Indonesia, smallholder hold the largest percentage of dairy cattle population which accounted for more than 95 percent (Badan Pusat Statistik, 2013). Furthermore, Badan Pusat Statistik (2013) through data census reported that number of household for dairy farms accounted for around 142 thousands households. Smallholder dairy farmers were majority in Java island (accounted for more than 99 percent) which was dominated by East Java (almost 50 percent). Total dairy cattle population was 411 thousand heads. On average, farmers have two to five cows per farm (Badan Pusat Statistik, 2013; Priyanti et al., 2009).

2.2 Type of production system

Moran (2009) simplified the dairy production systems into two systems including traditional smallholder systems which are mostly in the developing countries and commercial large-scale industrial systems which are located majority in the developed countries. The main differences between those systems are : the size of the farm, the milk marketing systems, and the level of input and output. Characteristics of traditional smallholder systems are : small-scale, generally mixed farming system with crops, informal milk marketing systems, and low levels of farm inputs and outputs. In addition, these systems have limited role into dairy policy making. Otherwise, commercial large-scale industrial systems are characterized by large scale production system (large herds and high levels of inputs and outputs), integrated marketing system with long market chains, and high technology adopted. Furthermore, they have a key role to the dairy policy making.

2.3 Challenges to be sustainable in the future

At a global scale, dairy farmers desire to have profitable and sustainable business to secure their livelihood (Moran, 2009). However, smallholder farmers to face several constraints to be sustainable. IFCN (2005) reported that high input prices and low output returns are the main challenges for small scale dairy farmers at a global scale. In addition, policy factors included global market, local or national market and environmental issues are also important to be addressed. Furthermore, production factors (capital, labours, land, animal), farm strategic factors (optimal farm size, diversification, production cost) and the direct farm factors (feeding, breeding, animal health) still need to be improved.

In the African tropical countries, smallholder dairy farm also face some limitations. In Tanzania the constraints were lack of finance, feed shortage, low milk price, low milk production performance, and health problems (Nkya et al., 2007). Those constraints were also exist in another country in Africa, for instance in Malawi. Tebug et al., (2012) explained that unreliable supply for animal genetic, poor animal health, and feed shortage were the three main important challenges that need to be solved. Meanwhile, in Uganda, the main limitations for dairy production were lack of feed, lack of basic knowledge and

livestock health. Meanwhile, in the marketing sector, the challenges were poor price, fluctuation in price and perishable product (Atuhaire et al., 2014).

In Asia, Devendra (2001) identified several farm constraints including: choice of species and breeds and the availability of animal, feed quality and resources, animal health, waste management, and organized market and market outlets. Furthermore, using the case of China, India, and Pakistan, Moran (2009) mentioned that low milk yield, high feed prices and shortages of feed, insufficient veterinary and breeding services, access to credit, access to markets, strong informal sector, and low adoption of technology remain become challenges to be solved. In China particularly, FAO Regional Office for Asia and the Pacific (2009) indicated that smallholder farmers face two main problems included low quality of milk that could not meet quality standard and poor remuneration resulting low income. In addition, Poulton et al., (2010) mentioned that smallholder farms face some difficulties in particular limited production factors (herd size, feed, workers and land access) resulting limited family income.

Farmers respond differently to these limitations. Some farmers adapt by adding on farm activity (García-Arias et al., 2015; Meraner et al., 2015) and off farm activity (Barrett et al., 2001; García-Arias et al., 2015). However, some others choose to abandon dairy business (García-Arias et al., 2015).

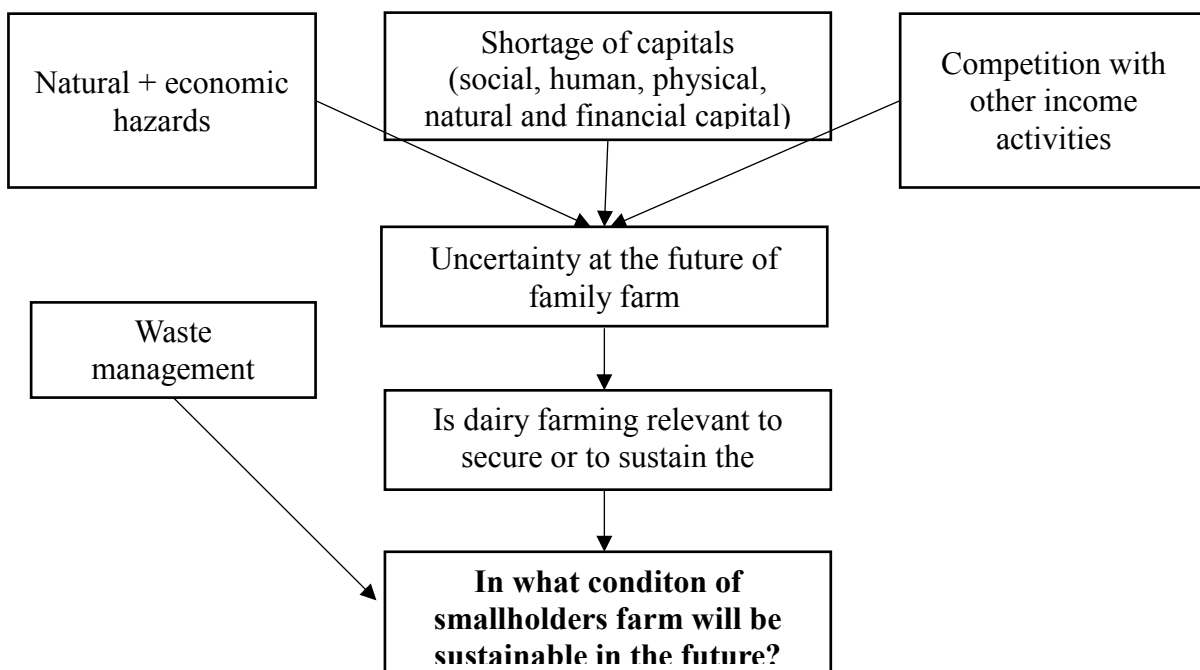
To have better understanding in the sustainability of dairy farming system in Indonesia, a study was conducted in Ciater and Lembang sub-district, West Java Province. Those areas were chosen because government had set the areas as one of dairy production center in Indonesia. The study focused on the evaluating of sustainability to understand which farms and why some farms had better sustainability in one dimension than others. In addition to that, a study was added to better understand the choices of smallholder farms and the dynamics of their farm toward sustainability. Through describing the farm typology, calculating the economic performance, identifying the process and the farmers strategy to be sustainable in the future, it also allowed us to learn in which type of farm that important to support national dairy development.

3. Problem Statement

We classified several constrains of smallholder dairy farms in Indonesia as “shortage of capitals” (Figure 13). Shortage of capitals become main challenges to be addressed by smallholder farms. Farmers face not only lack of physical capital, but also human capital, social capital and technical capital.

In addition, dairy farming face external challenges, i.e natural (water rессources contain sulfur) and economic hazard (increasing of feed price, low price of milk). Dairy activity also compete with other activity generating income such as tourism that attract farmers to have better income. All of these constrains resulting uncertainty at the future of family farm. Under these circumtances, a proposed question need to be answered: “is dairy farming relevant to secure or to sustain the livelihoods of rural smallholders?”. Furthermore, considering environmental aspect, a main question is proposed to be answered, “In what condition of smallholder dairy farming system will be sustainable in the future?”. It is important because nowadays environmental aspect becoming main issue at a global scale. In addition, majority of dairy farmers still do not aware about environmental aspect, in particular waste mangement. In this study, we will learn what condition and why it happens.

Figure 13 Problem of the dairy farming system toward sustainability

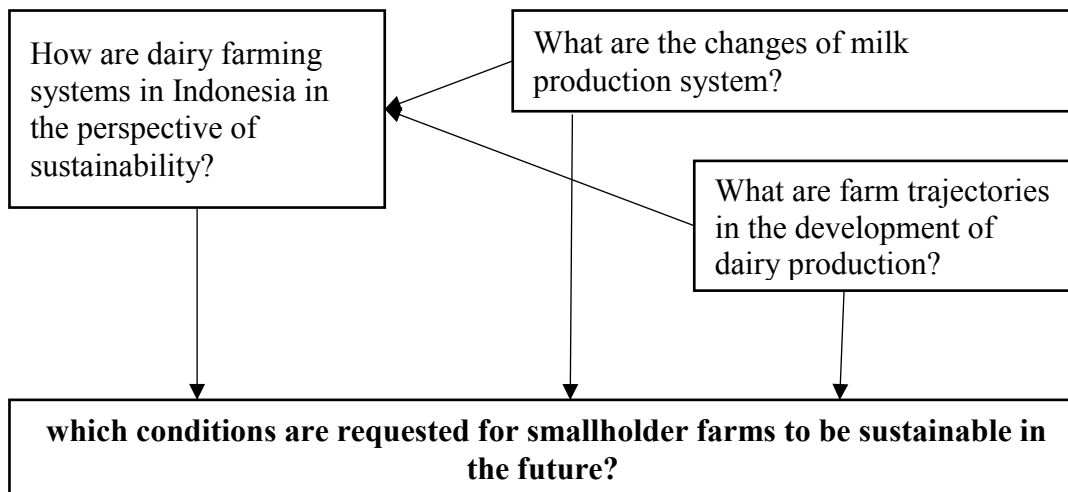


4. Research question

In the present research thesis, a principal research question is proposed: **“which conditions are requested for smallholder farms to be sustainable in the future under Indonesian context?”**. To have respons to this question, three sub-questions need to be answered (Figure 14), as below:

1. How are dairy farming systems in Indonesia in the perspective of sustainability?
2. What are the changes in milk production system?
3. What are the farm trajectories in the development of dairy production?

Figure 14 Main question and sub-questions of the study



Finally, the objectives of the overall study are:

1. **To better understand the condition of farms are more sustainable**
2. To evaluate the sustainability of dairy farming system.
3. To assess the dynamics and the changes of milk production system.
4. To understand farm trajectories in the development of dairy production.

MATERIAL AND METHOD

1. State of Art

1.1 *The Concept of sustainability in Agriculture*

The concept of sustainability in agriculture was widely proposed since more than two decades. Zahm et al. (2007) cited the definition of sustainable agriculture from Harwood (1990) in Bonny (1994), as “*a system that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment which is favourable to humans and most other species*” (Harwood, 1990 In Bonny, 1994). Francis and Youngberg (1990) in Bonny (1994) also mentioned that “*Sustainable agriculture is agriculture that is ecologically sound, economically viable, socially just and humane*”. This concept was confirmed by Weil (1990) who underlined three concerned areas included economic concerns, environmental concerns, and public welfare concerns. The economic concerns were related to economic justice, profitability, and the survival of farm owner. The environmental concerns were related to the impact of agriculture on natural resources. Therefore, public welfare concerns were related to food quality.

Several studies had mentioned that the common concept of sustainability was described as “three pillars” consist of an economic, environmental and social pillars (Lebacqz et al., 2013; Suess-Reyes and Fuetsch, 2016). Economic sustainability is characterized by the income from agricultural business to avoid the dependency from off farm activity. Ecological or environmental sustainability refers to natural resource preservation. Social sustainability is often defined as work-life balance (Suess-Reyes and Fuetsch, 2016). Furthermore, Pretty (2008) explained four key principles of sustainability consist of: integrating biological and ecological processes; minimizing the use of non-renewable inputs; improving the knowledge and skills of farmers to enhance their self reliance; and boosting capacities of people to work together to address common problem.

1.1 *Typology of farm to identify production system*

Typology is widely used to characterize production system (Andersen et al., 2007; Cortez-Arriola et al., 2015; Gabbi et al., 2013; Kaouche-Adjlane et al., 2015; Riveiro et al., 2013). At a global scale, scientist develop farm typology to understand the diversity of farm and its drivers (Andersen et al., 2007; Gaspar et al., 2008). Considering the diversity is useful to develop appropriate agricultural policy and to adopt new technology

(Pacini et al., 2014). A typology also allows to assess an integrated indicators of farm management (Andersen et al., 2007). Landais, (1998) explained that farm typologies play an important role to reduce heterogeneity by grouping farms based on their similarity.

A typology of farm has been established in several studies commonly used by statistical approach (Daloğlu et al., 2014; Ion et al., 2015). Scientists performed Principal Component Analysis (PCA) and Hierarchical Cluster Analysis (HCA) (Kaouche-Adjlane et al., 2015; Riveiro et al., 2013) for the quantitative data; Categorical Principal Analysis and two-steps cluster analysis (Abas et al., 2013); and Multiple Correspondance Analysis (Thenail, 2002) for the qualitative data. Multiple Factor Analysis (MFA) and Hierarchical Cluster Analysis (HCA) were also applied to establish a typology of dairy farming system. MFA can be used if the group of variables belong to the different types of data (quantitative or categorical data) (Pages, 2004). This analysis can balance the influence of the groups on the first principal dimension (Kostov et al., 2013). ANOVA (quantitative data) and Chi-Square (qualitative data) often used to compare of means between type of farms (Riveiro et al., 2013). Not only statistical techniques, judgement from local expert can be used to develop farm typology (Landais, 1998) or combination between statistics and other techniques (Riveiro et al., 2008).

1.2 Sustainability assessment of dairy farming system

To build sustainable farming systems, sustainability assessment is needed (Van Passel and Meul, 2012). It underlines the importance of sustainability assessment. Numerous studies have been conducted to assess dairy farm sustainability (Zahm et al., 2007). Three aspects are important consist of social aspect, economic aspect and environmental aspect (Lebacqz et al., 2013; and Hennessy and Teagasc (Organization), 2013). The overall sustainability indicators at farm level according to 3 aspects (Lebacqz et al., 2013) are: 1) environmental sustainability: level are input management (nutrient, pesticides, non-renewable resources, and land management) and quality of natural resources (biodiversity, emission of greenhouse gases, emission of acidifying substance, physical soil quality, chemical soil quality and biological soil quality); 2) economic sustainability: profitability, autonomy, diversification and durability; 3) social sustainability: internal

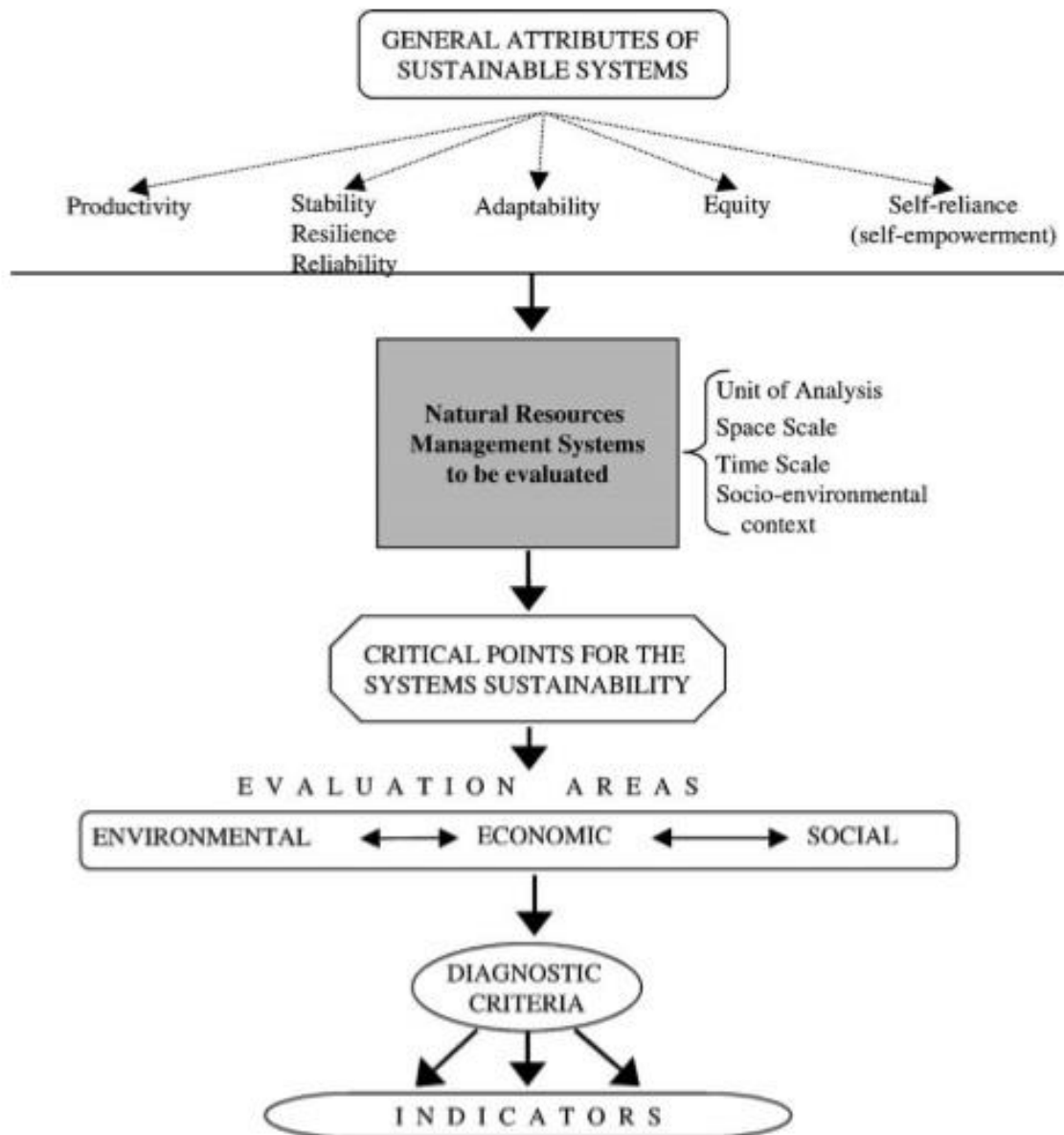
social sustainability (working condition, education, quality of life) and external social sustainability (multi-functionality, acceptable agricultural practices, quality of product).

There are several tools that have been used to assess sustainability at farm level, for example DSI (Dairyman Sustainability Index) (Elsaesser et al, 2013) in North-West Europe, TEAGASC in Ireland (Hennessy and Teagasc (Organization), 2013), RISE (Response-Inducing Sustainability Evaluation) (Häni et al., 2003), MOTIFS (Monitoring Tool for Integrated Farm Sustainability) (Meul et al., 2008), IDEA (Indicateurs de Durabilité des Exploitations Agricoles) (Ikhlef et al., 2015), PG (Public Good) (Gerrard et al., 2011); and combination between SVA and MOTIFS (Van Passel and Meul, 2012).

Several studies also have been conducted to evaluate sustainability of farming system with MESMIS framework (Astier et al., 2012; López-Ridaura et al., 2002; Speelman et al., 2007). Different with approach that mentioned previously, the MESMIS framework according to López-Ridaura et al. (2002) allows the derivation, measurement, and monitoring of sustainability indicators as part of a systemic, participatory, interdisciplinary, and flexible evaluation process adaptable to different levels of data availability and local technical and financial resources. In this approach (Figure 15), sustainability is defined by seven attributes (López-Ridaura et al., 2002; Speelman et al., 2007): (a) productivity, (b) stability, (c) reliability (d) resilience, (e) adaptability; (f) equity; (g) self-reliance (self-empowerment). Critical points of management system which would be evaluated are specified from these attributes. These critical points might be of an social, environmental, or/and economic nature. Therefore, these attributes will be used to define the diagnostic criteria and indicators of sustainability.

MESMIS framework have been largely used in Mexico and Spain. Various studies using this framework to assess the livestock farming system (Astier et al., 2012; Gaspar et al., 2009; Salcedo and García-Trujillo, 2005) and dairy farm as well (Ripoll-Bosch et al., 2012; Toro-Mujica et al., 2014). However, this approach have challenge in particular to evaluate the dynamic of agricultural system (Astier et al., 2012; Ripoll-Bosch et al., 2012). Some improvement and experience in many case study had already done to face this challenge (Astier et al., 2012; Speelman et al., 2007).

Figure 15 The MESMIS evaluation framework: linking attributes for sustainability to indicators



Source: López-Ridaura et al. (2002)

1.3 Performing trajectory analysis to identify the dynamic of production system

Several studies related to farms trajectories have been conducted throughout countries to understand how farmers have adapted to changes. Generally, the types of approaches according to Madelrieux et al. (2014) and Dedieu (2009) consists of: compares system states between date-to-date (García-Martínez et al., 2009); across a multi-date timeline (Ryschawy et al., 2011); and focus on the processes of change (Moulin et al., 2008).

In Mediterranean mountain areas (Spain), a study of agricultural trajectories and farming systems that are entirely transforming the social and environmental characteristics have been conducted by using a methodological approach based on the combination of multivariate statistical techniques (García-Martínez et al., 2009). In France there were several studies to understand farm trajectories. A study by Ryschawy et al., (2011) to analyze a typology of trajectories has been conducted with similar method. A spatial-temporal multivariate analysis method has been used by Rueff et al., (2012) to describe the changes in individual farms and households. A trajectory study of dairy farm in particular has been done by Begon et al., (2009) by using the pluri-disciplinary approach proposed by Moulin et al., (2008). The aim of the study was to analyse the different strategies of maintaining a dairy activity within a territory and the tensions related to such farming systems. The trajectory analysis is important to understand what farmers' strategies to ensure family income. By understanding farm trajectories, appropriate strategies for a sustainable dairy development can be designed.

2. Time and study area

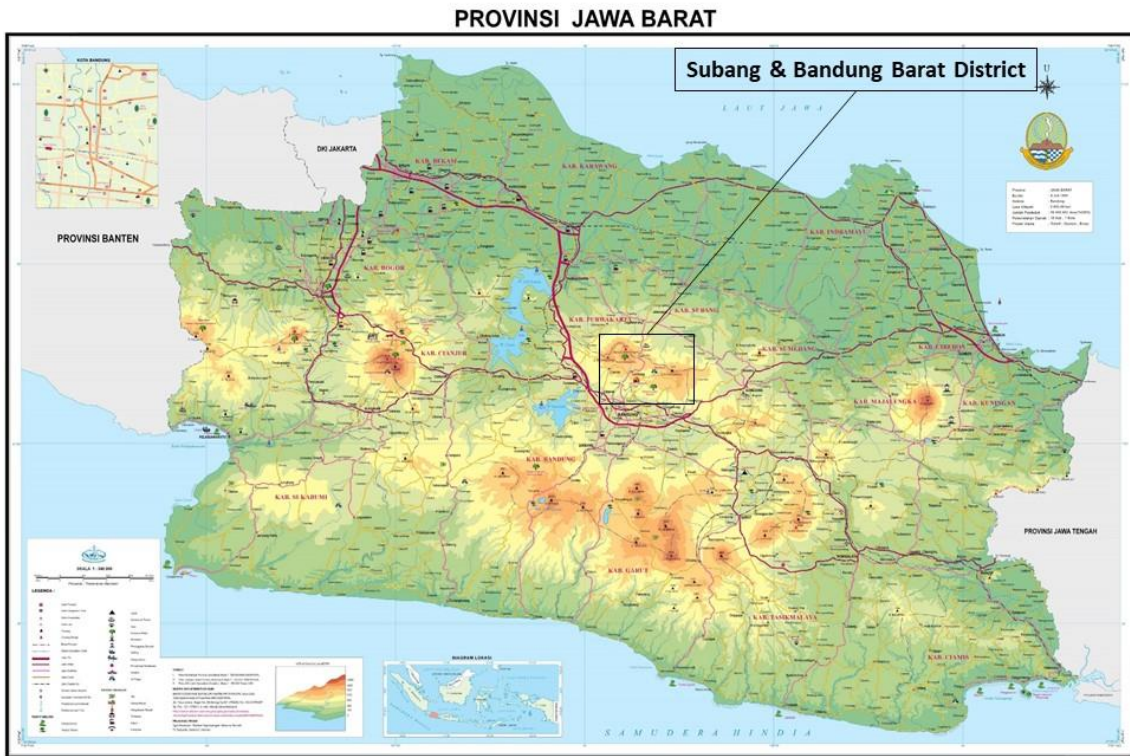
A study was conducted in Bandung Barat and Subang district, West Java Province (Figure 16). Study areas were chosen because those were the main work area of an important milk cooperative in Indonesia (KPSBU - *Koperasi Peternak Sapi Bandung Utara*). In 2011, members of this cooperative were more or less 7000 dairy farmers with more than 22 thousands of dairy cows (KPSBU, unpublished data). This cooperative produced 140 tons milk per day. According data from Ministry of Cooperative, Small and Medium Business, KPSBU was the biggest cooperative in West Java with total asset reached 115 billion IDR (equals US \$ 8.5 million) in 2012.

Bandung Barat district has sixteen sub-districts and its area covered 1305 km². This district has a high potential in agricultural production in particularly dairy business due to the existence of fertile soil, the river, the wet and cool climate. The altitude is more than 700 m. Average monthly rain fall was fluctuative in the last three years. In 2013, the monthly rain fall was on average 184 mm but it drastically decreased in 2015 which was only 70 mm per month. In 2015, the density was 1280 inhabitants per km² and of around 24 percent of people aged more than 15 years old worked in the agricultural sector. Dairy

cow population was more than 37 thousands cows which was 58 percent in Lembang sub-district (Badan Pusat Statistik Kabupaten Bandung Barat, 2016). Majority of dairy farmers are members of KPSBU milk cooperative. Due to this condition, Indonesian government through decree No.43/Kpts/PD.010/2015 of Minister of Agriculture assigned Bandung Barat district as a dairy business area. However, in the last three years, Badan Pusat Kabupaten Bandung Barat (2016) reported a land conversion from potential agricultural land to housing and this might affect the sustainability of the agricultural sector in particular dairy sub-sector.

Subang district covers 6,3 percent (2050 km²) of West Java Povince area. Subang has thirty sub-districts which only four sub-districts have the altitude of more than 500 m. The sub-districts in Subang are working area of KPSBU included Ciater, Sagalaherang, and Jalancagak (in the border of Bandung Barat district) which hold more than 80 percent of the total population of dairy cows in the district (Badan Pusat Statistik Kabupaten Subang, 2016). Dairy activity progressed rapidly, when KPSBU in partnership with private company extended their work area to those sub-districts since 2007 in order to increase milk production.

Figure 16 Map of Study area in Bandung Barat Regency and Subang Regency, West Java Province

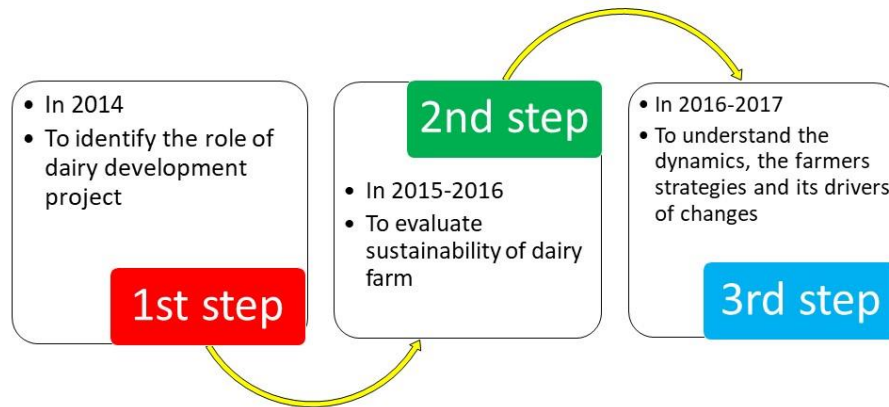


Source: big.go.id

source: big.go.id

A study has started from 2014 to 2017 in three main phases (Figure 17). In 2014 (first phase), a study was conducted to identify the role of dairy development project in Subang district where the dairy development project was exist. In 2015 (second phase), we enlarged the sample (not only in Subang, but also in Bandung Barat district) to understand in what condition farm is more sustainable. Lastly (third phase), from 2016 to 2017, we did a diachronic study in order to identify the dynamic and to understand the farmer's strategies and its drivers to ensure family income and to provide national milk market.

Figure 17 Main phases of the study from 2014 to 2017



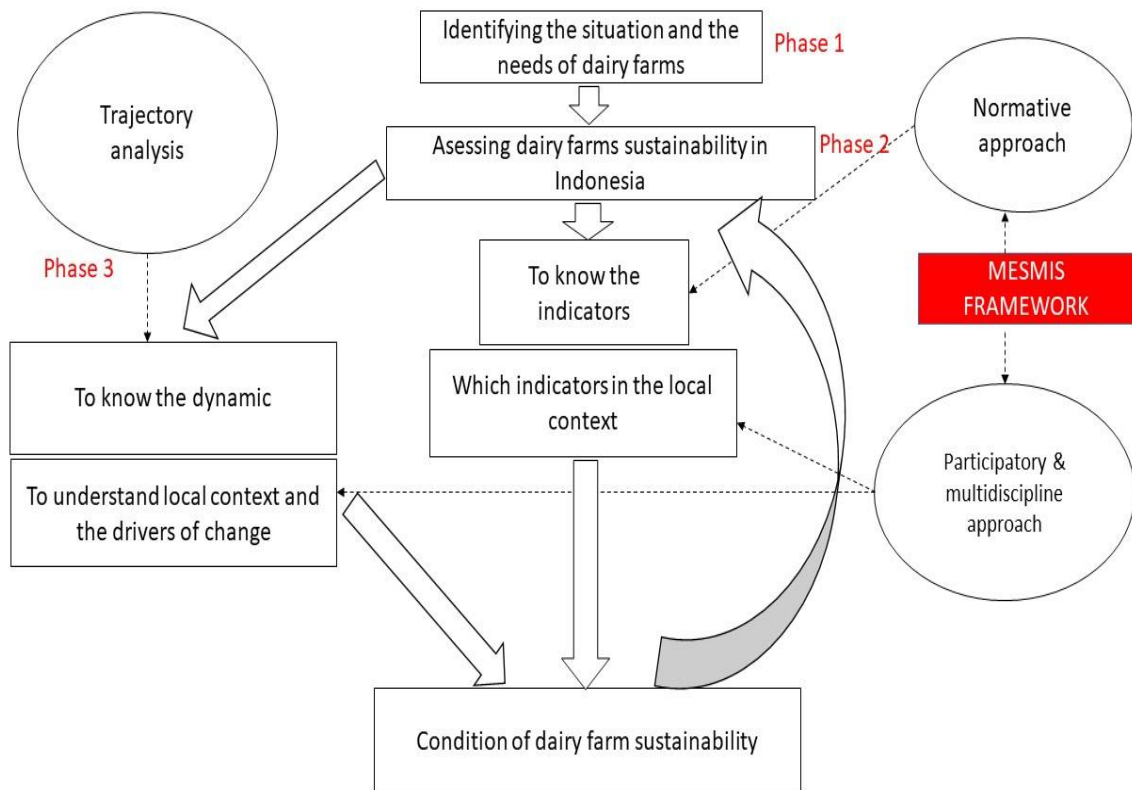
3. Research framework

To understand the conditions to have sustainable smallholder farms in the future, a three years study was conducted (Figure 18). Firstly, a study was conducted to identify the role of dairy development project in the study site (first phase, particularly in Subang district). It also allows to understand the situation and the needs of dairy farms in the area. A dairy development project was exist since 2007 to 2009 (first period) and from 2011 to 2014 (second period). In the first period, the project provided credit to purchase three pregnant cows and trainings to the dairy farmers. Since that year, population of dairy cows and dairy farmers sharply increased. In the second period, the project provided not only credit but also training in the dairy farming practices and renovation of barn at the aim to improve farmers' livelihood.

Secondly, a study was done to assess the sustainability of dairy farming system (second phase). Before starting the assesment, the indicators of sustainability have been built. In the several studies, there were tools and approach to set the indicators. In the present, a MESMIS framework was adapted to set it. The framework was chosen due to systemic, bottom-up, participatory, flexible and multidiscipline approach (López-Ridaura et al., 2002). This framework was appropriate to select which indicators in the local context.

Thirdly, a further study was conducted for a better understanding of the dynamics of dairy farming system (phase 3). A diachronic study (trajectory analysis) allows us to learn and clearly understand the local context and the drivers of change. This study was important to identify the dynamics of smallholders to ensure family income. Furthermore, it allows us to understand strategies for the sustainable dairy development in Indonesia. In the end, a question of “in what condition smallholders farm will be sustainable in the future?” could be clearly answered.

Figure 18 research framework



4. Research phases

The present study has three main phases as mentioned before (Figure 18 and Figure 19). First phase is to identify the role of dairy development project and to understand the situation and the needs of farms, a study was conducted. It focused on assessing the technical-economic performance of the farms at the time of the survey, and comparing their performance with those reported four years earlier in the same area. The information was collected through formal survey up to 61 farmers in Subang district, interview with stakeholders, field observation, and literature review. To complete the information, secondary data were provided from KPSBU and local authorities.

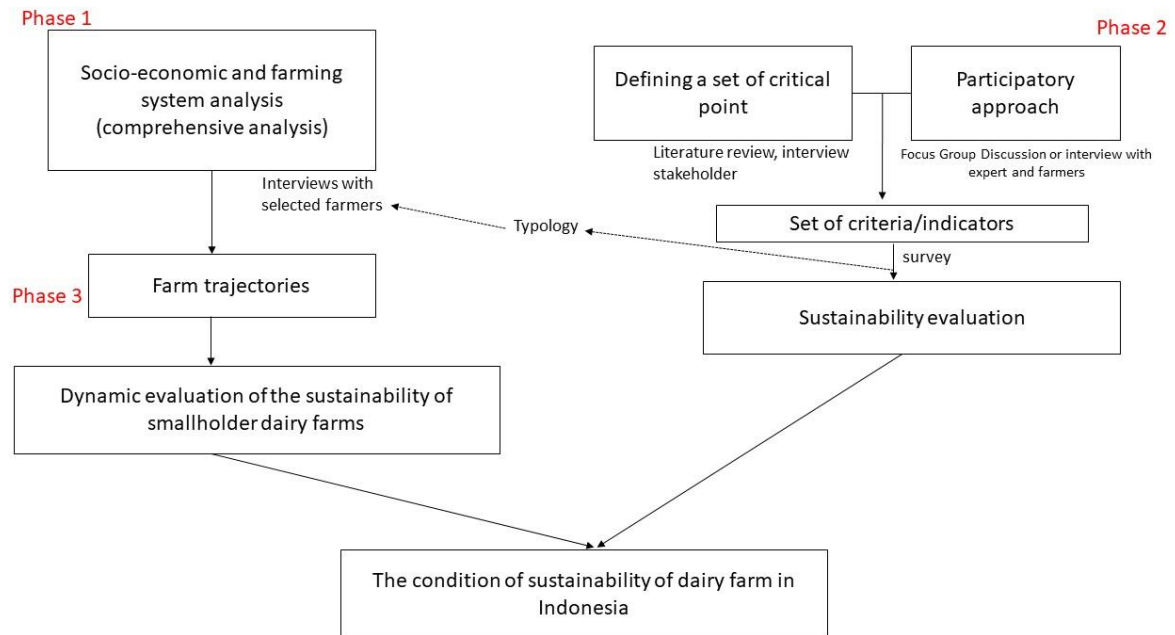
Second phase, a sustainability assessment study was done. MESMIS framework was adapted as proposed by López-Ridaura et al., (2002) to build the indicators of sustainability and to assess dairy farm sustainability. A set of critical points were identified from previous study and literature review. An in-depth interview with stakeholders was done to take into account their point of view. Criteria and set of indicators were built to assess the sustainability. To simplify the assessment, only selected indicators were chosen based on their level of importance. The most important indicators of each pillars were used to assess the sustainability of dairy farming system. An assessment was conducted through formal survey to 355 farms and field observation (Table 2). To complete the information, data were also collected from KPSBU and local authorities.

Third phase, a study was carried out to understand the dynamic of dairy farming system toward sustainability. A method proposed by Moulin et al., (2008) was carried out to analyze the different farm strategies in maintaining a dairy activity. From previous phase, farm typology was built. Total 20 farmers were selected as a representative of each type. Two times in-depth interview for those farmers were conducted. It was to understand the strategy of farmers to maintain dairy business. Data from KPSBU and local authorities were also collected to complete the information.

Table 2 Number of farms for each assessment

Assessment	Subang (farmers)	Bandung Barat (farmers)	Total farmers
Role of dairy development project	61	0	61
Sustainability Assessment (multicriteria)	104	251	355
Trajectory Analysis	8	12	20

Figure 19. Study phase in Bandung Barat and Subang district Indonesia



CHAPTER 1

CHAPTER 1. The role of dairy development project

Chapter's Introduction

A dairy development project was exist since 2007 (first period) and 2011 to 2014 (second period) in Ciater sub-district, West Java Province. The project was a collaboration between a private enterprise, milk cooperative (Koperasi Peternak Sapi Bandung Utara-KPSBU), NGO, university and local stakeholders. The main objective of the project was to develop the dairy sector in the area and to boost farmers' livelihoods. Before 2007, dairy farm was not a main activity. They were mostly wage workers in State Tea Plantation (PTPN).

In this chapter we have two starting questions to be addressed. First is “what is the the role of the dairy development project?”. Second is “what is the situation and the needs of dairy farmer?”. This chapter aim at identifying the role of dairy development project in Ciater sub-district. In addition, it also allowed us to understand the needs and situation of poor dairy farmers. It is then important as a first step to response a thesis sub-question concerning “what are the condition of farming system in the perspective of sustainability?” .

Our hypothesis was the dairy development project could increase the farmers' livelihood by the increased of their capital. The dairy farming activity remain important for poor farmers to cover daily expenses

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Title: Improved milk production performance of smallholder farms in West Java (Indonesia)

Running Title: The role of dairy development project

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ABSTRACT

In Indonesia, because of the rapidly growing demand for dairy products, the development of milk production in rural communities can play a strong role in reducing poverty. However, the development of smallholder dairy production requires adequate support from the government, development organizations, and private firms. To assess the needs and situations of poor dairy farmers, we conducted a study in Ciater sub-district in West Java Province to compare the current situation with the situation that prevailed four years ago, i.e., before the implementation of a dairy development project. Data were collected from 61 farms in June 2014. The average number of cows on the farms surveyed was three to four, and each relied on cultivating an average of 0.4 hectares of forage. Results showed that thanks to the project activities, milk productivity per cow and net income from milk production increased by 25% between 2010 and 2014. These results underline the importance of providing training and technical support for the development of the livelihoods of dairy smallholders.

Keywords: Milk production, dairy development, smallholder farmers, Indonesia

INTRODUCTION

In Indonesia, the livestock sector plays an important role in the rural economy. In 2010-2011, animal production accounted for around 12% of agricultural GDP (*Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2013*). Dairy production, in particular, plays an important role on smallholder farms. Most dairy farmers in Indonesia own only two or three cows (Taslim, 2011).

Historically milk consumption in West Java has been low, but the dairy sector is now developing rapidly in response to the increased consumption of dairy products. National milk production increased from 827,000 to 981,000 tons between 2009 and 2013. West Java province is the 2nd largest milk producing province (after East Java); it produced 293,000 tons in 2013 (*Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2013*). Very few authors have analyzed changes in the profile of dairy farms. In addition, it is very difficult to assess the main constraints to the development of smallholder farming because of the diversity of agro-ecosystems across provinces and districts (Marten and Abdoellah, 1988).

To understand the problems and opportunities for the development of milk production on smallholder farms in West Java, a survey was conducted in Ciater sub-district, Subang Regency. The study area was chosen because a development project had recently been implemented to support smallholder dairy development. Our research focused on the dynamics of dairy activity by assessing the technical-economic performance of the farms at the time of the survey, and comparing their performance with those reported four years earlier in the same area (Sahabat Cipta Foundation, 2011).

METHODS

Study site

Ciater Sub-District, (Subang Regency, West Java Province), is a high plateau with an average altitude of 807 m. The cool wet climate is favorable for dairy cows and for the cultivation of forage. The total area of Ciater sub-district is 4,710 ha of which about 28% is rice fields and 21% is tea plantations (Badan Pusat Statistik Kabupaten Subang, 2014); the population density is 615 inhabitants/km².

This area was chosen in 2007 by the milk cooperative of North-Bandung (*Koperasi Peternak Sapi Bandung Utara - KPSBU*), a private dairy processor and the Indonesian Government to develop milk production as a way of improving the livelihoods of smallholder farmers. The name of the project was Dairy Development in Ciater Project (DDCP). The first phase of the joint project started in 2007 in collaboration with a private bank which provided credit to farmers to purchase dairy cows and set up milk collection groups. In 2011, the second phase of the project was launched with the support of a private dairy processor in partnership with KPSBU, Sahabat Cipta Foundation (a non-governmental organization) and the others (Tawaf & Surianingrat, 2010). The aim was to improve the overall livelihoods of farmers in the local communities.

Research Design

The survey was conducted from April to September 2014. To understand the whole production system of the farms and the factors impacting performance, we conducted a descriptive and comparative study using both primary and secondary data.

Secondary data were obtained from literature of KPSBU, the Sahabat Cipta Foundation, and public authorities. To obtain more in-depth information than that available in secondary data, primary data were collected in interviews with local stakeholders, through direct observations, and in a formal farm survey. The surveys were conducted in June 2014. We then compared the performance observed in our survey with the situation at the beginning of the second phase of the development project, using data from the 2010 baseline survey conducted by Sahabat Cipta Foundation (2011).

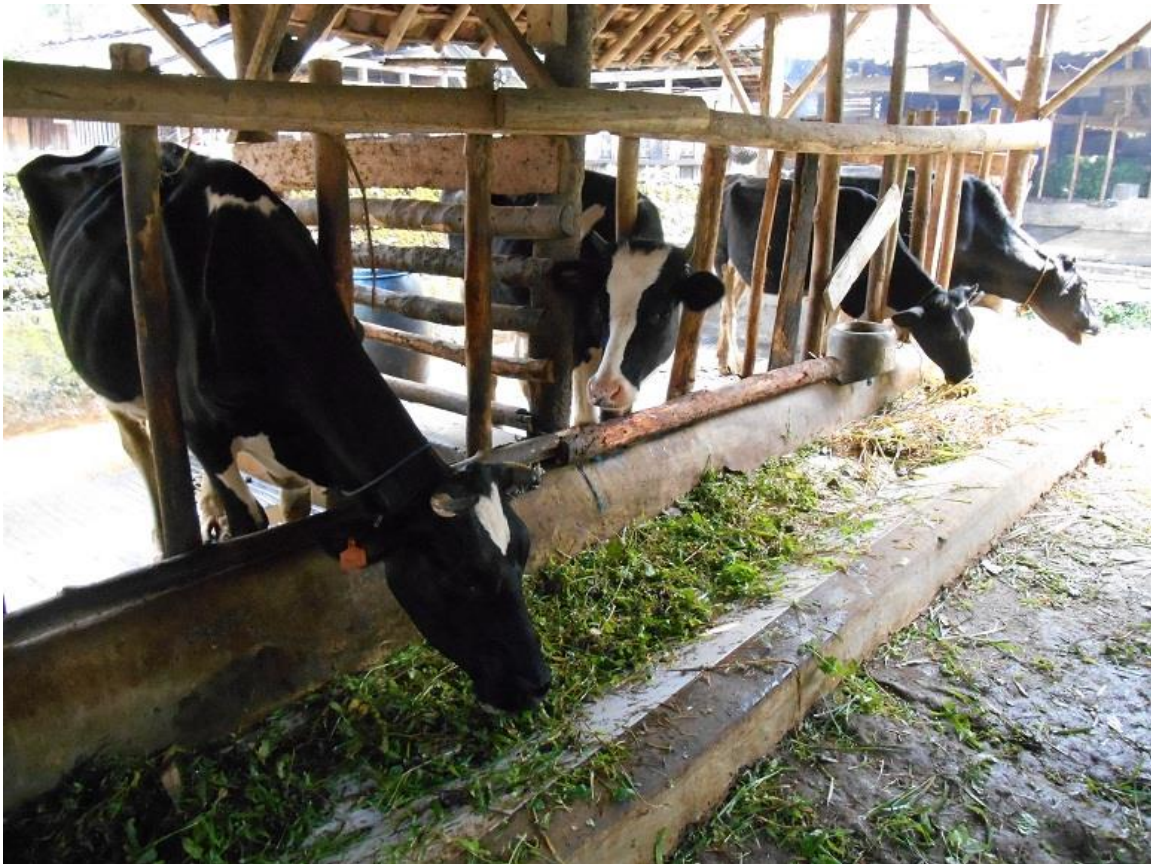
Sampling

The total population of milk producers in Ciater sub-district comprised 131 farmers, all members of the same cooperative. According to the management of the project, dairy farmers in the area were divided into two groups: Demonstration “demo” farms and “other” farms. The “demo” farms were farms selected by the project at the beginning of the second phase to become demonstration farms. Our survey covered a total of 61 farmers including 11 “demo” farms (Figure 20) and 50 “other” farms (Figure 21) randomly chosen among all the villages of the sub-district (Table 3).

Figure 20. The Demo Farm in Ciater



Figure 21 The “other” farm in Ciater



Information and variables taken into account

The information collected to characterize farms and their performance was divided into three categories, (i) socio-demographic characteristics, (ii) dairy farming facilities and practices, and (iii) technical-economic performance.

Table 3 Survey of farms

Description	“demo” farms	“other farms”
Grant for facilities	Building of a new barn to hold 4 cows and 2 calves	Renovation of feeding facilities
	Building a meeting room	Installation of ad libitum water drinking system for cows
	Installation of ad libitum water drinking system for cows	
Grant for the purchase of equipment	Milk can, milking bucket	Milking bucket
Loan for the purchase of cows	All farmers	Some farmers
Training course	Direct (Training by trainer)	Indirect (pictorial training modules and sharing with the “demo” farmer)
Total number of farms	11	120
Number of farms surveyed (%)	11 (100%)	50 (42%)

The farmers’ socio-demographic characteristics included the age of the farmers, their education level, experience in dairy farming, and land ownership. Dairy production facilities (capital invested in dairy production) included herd size, number of lactating cows, total forage area (owned and rented), barns and other facilities, equipment, participation in training courses and in meetings. Barns and facilities were assessed using

a “barn condition score” developed by the Ministry of Agriculture (*Direktorat Jenderal Peternakan*, 1983). Dairy farming practices included labor organization and procedures, techniques and utilization of feed. The quantity of feed was assessed through (i) daily quantity of green forage provided on the day of the survey, and (ii) the dry matter of the concentrate calculated using the standards proposed by the National Standardization Agency of Indonesia (Badan Standardisasi Nasional, 2009).

Milk production performance included total milk production per farm, milk productivity per cow, milk productivity per working hour, total amount of milk sold to the cooperative and net income received from the cooperative. The last two variables were estimated from data provided by KPSBU. They referred to June 2014. Net income was defined as [Net Income = Total milk sales – (Cost of feed concentrate + Cost of vet services + Financial cost of credit reimbursement)]. Net income therefore included net profit and payment for family labor.

Data analysis

Data were summarised using descriptive and statistical analysis. Descriptive analyses included level of education, farmer’s age, farming experience, and land ownership. The other variables were analyzed using ANOVA (analysis of variance). In addition, Tukey’s test ($\alpha = 0.05$) was used to assess the differences between the group of “demo” farms and “other” farms and also between dairy farms before and after the development project.

RESULTS

Farmers’ socio-demographic characteristics

The farmers’ education level was mostly low; the majority of farmers (69%) had attended only elementary school, and only one had a bachelor’s degree (Table 4). Half the farmers were between 41 and 60 years old (Table 5). A total of 75% of the farms started milk production after 2004, and were therefore newcomers to dairy farming (Table 6). A significant number started dairy farming when KPSBU and partners started the dairy development program in 2007. Previously, the farmers had worked on tea plantations, in construction, or were rice farmers. Only a small proportion had experience in raising beef cattle.

Dairy farmers cultivated on average 0.54 ha; this included land owned by the family and land rented (Table 7). Most land was used to grow forage (78%) but some was planted with food crops.

Table 4 Farmers' education level

Education level	Number of farmers	Percentage (%)
Bachelor degree	1	2
High school	4	7
Junior high school	14	23
Elementary school	42	69

Table 5 Age of farmers

Age of farmer (years)	Number of farmers	Percentage (%)
15-25	2	3
26-40	24	39
41-60	30	49
>60	5	8

Table 6 Farmer's experience in dairy farming

Experience (years)	Number of farmers	Percentage (%)
1 to 5	8	13
6 to 10	38	62
11 to 20	6	10
>21	9	15

Table 7 Farmers' access to land in 2014

Land access	Forage production	Cropland	Plantation
landownership (m ² /farm)	2060 ± 4380	816 ± 2400	172 ± 781
Land rented (m ² /farm)	2190±3300	0	300 ± 0
Total	4250	816	472

Dairy farming facilities and milk production practices

Farmers had on average three or four cows, of which two were lactating at any time (Table 8). All cows were “Sapi Holstein” resulting from Holstein insemination of crossbred cows. Dairy cattle were kept in barns and were fed in zero-grazing systems with green forage (cut-and-carry) (Figure 22) and feed concentrate (Figure 23). Green forage included cultivated grass (mostly Napier Grass and King Grass), natural grasses and other fodder such as banana stems.

Figure 22 Forage included cultivated grass (a), natural grass (b), paddy straw, and silage (d)



(a)

(b)



(c)

(d)

Figure 23 Tofu waste (a) and concentrate feed (b)



The “demo” farms had better dairy production facilities than the “other” farms. Their livestock capital was significantly higher in terms of herd size (5.4 cows) and number of lactating cows (3.7). In addition, the “demo” farms had adopted a higher number of innovations (biogas and silage), and their barns were in better condition.

Farmers and their family members spent on average 7.3 working hours per farm per day on feeding and milking. “demo” farms spent more time due to the larger size of their herd. However, there was no significant difference between the two groups in feeding practices, training and attending meetings. Both groups fed the cows with an average of 44 kg of forage and 9.5 kg of dry matter concentrate per cow per day. The animals were fed two or three times a day. Farms grew their own Napier and King Grass on about 0.4 ha of land.

As members of KPSBU, dairy farmers purchased feed concentrates only from their cooperative. The raw materials used in the production of the feed concentrate were wheat pollard, coffee waste, cocoa waste, rice bran, palm kernel meal, soy sauce waste, cassava waste, copra meal, kapok meal and limestone.

Table 8 Dairy farming facilities and practices

No.	Variable	Group of farmers		Total (n=61)
		“demo” farms (n=11)	“other” farms (n=50)	
1.	Herd size (AU)	5.3±3.3 ^A	3.2±1.9 ^B	3.6±2.3
2.	Number of lactating cows (AU)	3.7±3.0 ^A	1.9±0.9 ^B	2.2±1.7
3.	Working hours (hours /farm/day)	9.0±4.1 ^A	6.9±2.4 ^B	7.3±2.9
4.	Number of innovations (units)	1.5±0.5 ^A	0.6±1.3 ^B	0.8±1.3
5.	Score			
	a. Using capital ^{ns}	27.2±20.9	20.3±12.7	21.6±14.5
	b.Had training ^{ns}	2.8±0.8	2.5±0.5	2.5±0.6
	c.Attended meetings ^{ns}	3.2±0.8	3.2±0.8	3.2±0.8
	d. Condition of barn	100 ^A	70.1±1.6 ^B	75.5±11.67
6.	Quantity of forage (kg green fodder/cow/day) ^{ns}	43.6±13.6	44.2±11.3	44.1±11.6
7.	Quantity of feed concentrate (kg DM equivalent/cow/day) ^{ns}	9.4±3.4	9.9±4.1	9.8±3.9
8.	Grant received by project:			
	For barn construction	100%	0%	-
	For stall renovation	100%	100%	-

Note: Means in the same column with a different superscript differ significantly (P<0.05);

ns= not significant

Source: survey (2014)

Technical-economic performance of dairy farms

In June 2014, the milk production per farm was significantly higher on the “demo” farms (1,290 liters/month) than on “other” farms (701 liters/month), mainly due to the difference in the size of the herds (Table 9). The productivity per cow and the productivity per working hours were slightly lower on the “demo” farms than on the “other” farms, but with no statistical difference.

Table 9 Technical-economic performance of dairy farms

No.	Variable	Group of Farmers		
		“demo” farms (n=11)	“other” farms (n=50)	Total (n=61)
1.	Total milk production (June 2014) (in liters)	1,290±877 ^A	701±412 ^B	806±564
	Milk productivity per cow (l/lactating cow/day) ^{ns}	11.9±2.1	12.6±3.8	12.5±3.6
	Milk productivity per working hour (l/working hour/day) ^{ns}	5.1±3.4	3.8±2.4	4.0 ± 2.6
	Total amount of milk sold to the cooperative in June 2014 (liters)	1170±1050 ^A	578±277 ^B	685 ± 545
2.	Net income in June 2014 from milk cooperative (million IDR/Month/Farm) ^{ns}	1.9±3.16	1.06±0.82	1.21 ± 1.53
	Net income from the milk cooperative (IDR/Farm/Day) ^{ns}	63,400±10,500	35,400±27,400	40,400 ± 50,800

Note: Means in the same column with a different superscript differ significantly (P<0.05);

ns= not significant

Source: survey (2014) + data from KPSBU

On average, the net income of a dairy farm in Ciater was 1.2 million IDR/month (equivalent to US\$101/month¹), but variability was high. Due to their larger herd size, the income received by the “demo” farms was higher than of the “other” farms.

Comparison of farm performance in 2010 and 2014

The data provided by KPSBU showed that the average quantity of milk sold each month to the cooperative increased from 630 litres per farm in 2010, to 780 litres in 2014. This corresponds to a 23% increase (Figure 24). This improvement can be explained by an increase in farm productivity: productivity per cow assessed in our 2014 survey was 25% higher (12.4 liters/day) than that in the 2010 baseline survey (9.9 liters/day) (Table 10). The increase in productivity per cow was mainly due to the adoption of new practices. The KPSBU data confirmed that there was no significant change in the number of lactating cows between 2010 and 2014. Farm income also increased by 25% between 2010 and 2014, with milk prices rising at the same rate as feed prices (Figure 26).

Overall however, the number of farms that sold milk to KPSBU decreased (Figure 25). Consequently, the total quantity of milk collected by KPSBU in Ciater decreased from 1.7 to 1.2 million liters per year. But the decrease in the number of farms that supplied milk to the cooperative was already smaller in 2013 and stopped at the end of 2014 (Figure 25).

Table 10 Comparison of the milk productivity per farm and of net income in Ciater in 2010 and 2014

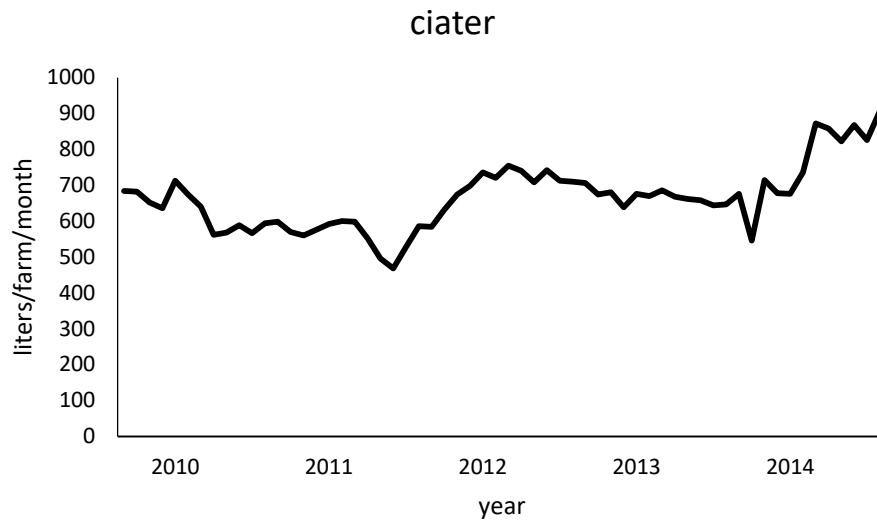
Performance indicators	Baseline 2010 (n=89)	All farmers 2014 (n=61)
Milk productivity per cow (l/lactating cow/day)	9.9±5.3 ^B	12.5±3.6 ^A
Net income from milk cooperative (IDR/farm/day) ^{ns}	32,300± 47,600	40,400 ± 50,800

Source: Sahabat Cipta Foundation (2011) for the 2010 baseline; and our survey for 2014 data

Note: Means in the same column with different superscript differ significantly (P<0.05); ns= not significant

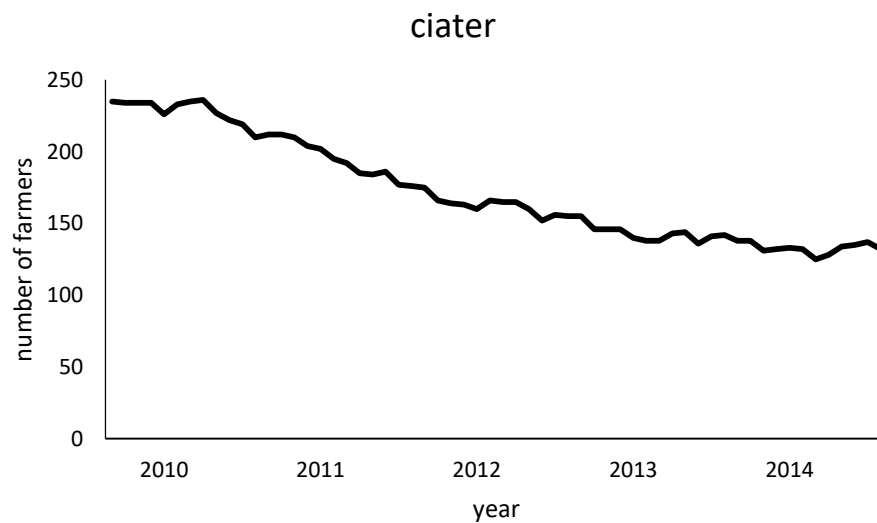
¹ 1 US\$=11888 IDR in June 2014

Figure 24 Milk per farm sold to KPSBU by farmers in Ciater (2010 to 2014)



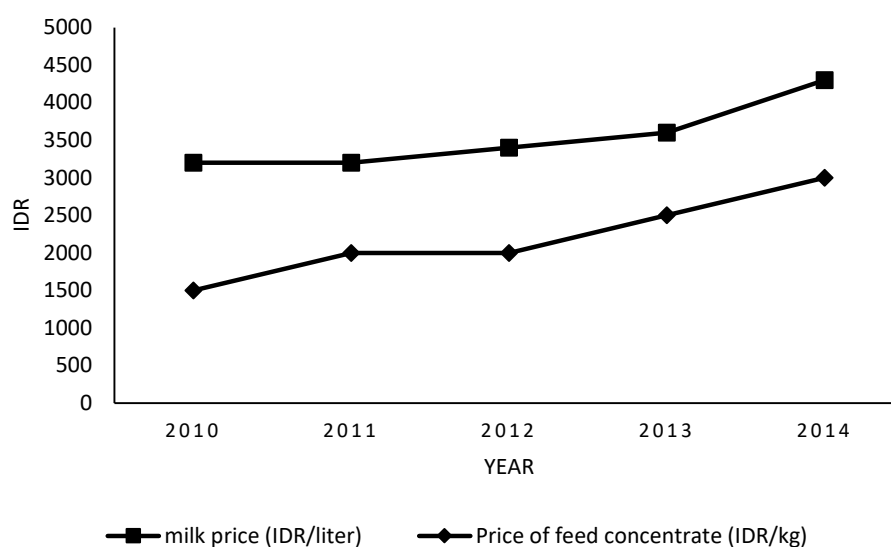
Source: KPSBU (2014)

Figure 25 Number of dairy farmers in Ciater who delivered milk to KPSBU (2010 to 2014)



Source: KPSBU (2014)

Figure 26 Increase in the price of milk collected and in the price of feed concentrate sold by KPSBU (2010-2014)



Source: KPSBU (2014)

Note: 1 US\$=11888 IDR in June 2014

DISCUSSION

The present shows that in the Ciater area, as in other parts of Indonesia, milk is produced by poor farmers who have very limited land and capital. Farmers are relatively poor and cultivate less than half a hectare of land. To complement their other activities (e.g. working on a tea plantation or taking off-farm employment), these farms produce milk with only two milking cows. In terms of working hours, this activity corresponds to a full-time job for one member of the family. The average dairy income is around US\$100 per month, which corresponds to the minimum wage in industry in this region. This situation confirms the dominance of smallholder family farming in the dairy sector, and its high economic potential for farmers with limited capital in Java (Taslim, 2011), as in other parts of the developing world (Nganga et al., 2010; Sajjad & Khan, 2010; Corniaux *et al.*, 2012; Hostiou et al., 2012).

In this context, the DDCP project played a major role in promoting improved dairy farming. By providing grants for stall renovation and training for all farmers in Ciater, and by providing credit and support for the renovation of barns on the 11 demonstration farms, they helped the whole community to progress in their dairy business. As a result,

farm productivity and farm income improved by 25% between 2010 and 2014, mainly due to the adoption of technical innovations, particularly feeding and watering practices.

Discussions with farmers revealed high variability of feeding and reproductive performance. In particular, inter-calving intervals on some farms appeared to be irregular, although we did not systematically collect data on this question. From an economic point of view, our results showed that increasing the size of the herd did not always increase the farmer's income if the technical performance of the herd is not managed adequately. Those results are consistent with the results of many studies that underline the importance of controlling technical parameters to boost the economic performance of dairy farms (Sajjad & Khan, 2010; Nganga *et al.*, 2010). In particular, Pandian *et al.* (2013) reported that the dry matter content of the feed concentrate and the use of green forage have positive impacts on the productivity of dairy cows.

One major problem for dairy farmers in Ciater is feed availability. Considering an average of 0.4 ha available for cultivation of forage, each farm has the capacity to produce 16.4 Kg of dry matter per day². Since farmers give on average 44 Kg of green fodder to each animal each day (equivalent of 5.7 Kg of dry matter³), cultivated forage is only sufficient for three cows, which is just below the average herd size. Farmers are therefore obliged to collect fodder outside the farm and to provide concentrate feed, particularly during the dry season. Given the difficulty that farmers face in the dry season, the DDCP project held training sessions on how to produce silage. This technique helps farmers improve their feeding system, especially during the dry season. Some activities were also organized by the project and by KPSBU to encourage the production of better quality forage crops including Guinea grass. The district also has a very good potential for pineapple cultivation, and pineapple waste could also be more widely used as a complement to forage.

² We used an average dry matter yield of Napier and King Grass of 15 tons dry matter per hectare and per year (Nell and Rollinson 1974), which is equivalent to 6 tons per year for 0.4 ha. This is equivalent to 16.4 kg of dry matter per day for 0.4 ha.

³ We used an average composition of 13% dry matter for King Grass (Moran, 2005).

The sharp drop of the number of dairy farms between 2010 and 2014 can be attributed to several factors, including the farmers' lack of experience in dairy production, the rise in meat prices and the parallel rise in the price of feed concentrate in 2011. However, with the improvement in farmers' technical capacity, and the rise in milk prices in 2014, this decrease has been stopped. The project therefore appears to have helped secure milk production in this sub-district.

One of the main challenges to increasing dairy farmers' income in the future is the need to help them increase the number of milking cows on their farm (taking access to land into account) by introducing appropriate credit schemes, in addition to promoting appropriate milk production models that include the intensive cultivation of forage.

Synthesis of the chapter

We carried out a preliminary study to identify the role of dairy development project and to understand the situation and the needs of smallholder dairy farm. This chapter clearly indicated that in the area, dairy farmers have limited capital. On average, farmers have two to four cows per farm with less than 0,3 hectare per farm. The existing dairy development project played a key role to increase farmers' livelihood. By the increased access to credit and technical support from the dairy project, it improved milk production performance. However, the activities of the project could not be enough to develop sustainable dairy farms. The project focus on increasing capital (cow and barn). It was a good start and it should be followed by the increasing other production factors such as access to land and forage.

This chapter is important as a initial step to understand in what condition dairy farming system will be sustainable in the future. By understanding situation and the needs of dairy farmers, we could characterize dairy farming system that will be important to evaluate the sustainability. To response the thesis research question, we proposed following chapters. First, we conducted the synchronic assessment of the sustainability of smallholder dairy farms. Second, we carried out the dynamic assessment in the farms' level for a sustainable dairy development.

CHAPTER 2

CHAPTER 2. The importance of working capital in the sustainability of smallholder farms in West Java (Indonesia)

Chapter's Introduction

After understanding the situation and the needs of farmers in the Chapter 1, we continue to evaluate the sustainability of dairy farming system. In the previous chapter, we identified the role of dairy development project as well as the situation and the needs of dairy farmers. On average, dairy farmers only have two until four cows per farm with limited land access (0,3 ha per farm). The dairy development project plays an important role to increase the milk production performance by providing credit and access to technical support. Even so, the sustainability of dairy farming system remains questionable.

In this chapter, we conducted a study to evaluate the sustainability of dairy farming system. The study aimed at understanding the sustainability of smallholder farms and identifying why some farmers have better sustainability in each dimension. In addition, it also allows us to describe pattern of sustainability. We added the sample up to six times higher than the previous chapter. We expect to have more reliable data and to capture complete picture of the situation of dairy farming system in West Java Province. This chapter is important to respond our research sub-question: “what are the condition of smallholder farms in the perspective of sustainability?”.

To start the study, we have some starting question to be answered. Firstly, it was about the indicators of sustainability: “what indicators to evaluate the sustainability of dairy farming system?”. Secondly, it was “what is the pattern of sustainability?”. Thirdly, it was “why some farms have better sustainability than others in each dimensions?”. Previous chapter could help us to confirm the pattern of sustainability by explaining the situation of dairy farms.

Our hypothesis, is that farms with higher capital will have better sustainability particularly for economic and social dimension than other farms. Higher capital farms will also have better economic performance that will promote higher level of sustainability in the future.

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The importance of working capital in the sustainability of smallholder farms in West Java (Indonesia)

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ABSTRACT

Smallholder farms represent the largest population of dairy cattle farms in Indonesia. Dairy activities can play an important role to secure the livelihood of smallholder farms. However, small farms have several constraints and challenges to be sustainable in the future. To assess the sustainability of smallholder dairy farms and to understand in what condition farms are more sustainable, we conducted a study in Subang and Bandung Barat district in West Java Province. We collected primary and secondary data from May 2015 to May 2016. We carried out a formal survey of 355 farmers from May to August 2015. From discussions with local stakeholders and literature review, we propose 6 indicators of sustainability scoring from 0 to 100. Result showed that the most sustainable were farms which had high capital and diversified activity (farms pattern 5). Farms which had low capital but had additional activity (pattern 1) were more sustainable than specialized farms with low capital (pattern 2 and 3). Capital plays an important role to all 3 pillars of sustainability. In addition, diversity contributes to reduce risks related to dairy business and to benefit from synergies between activities. Our study underlines the importance of enhancing farm capital and diversification of rural households for increasing the sustainability of smallholder farms.

Keywords: Assessment, sustainability, smallholder farms, Indonesia

INTRODUCTION

Smallholder farms play an essential role to the development of dairy sector in Indonesia. They represent the largest ownership (93%) of the national population of dairy cattle. Badan Pusat Statistik (2013) reported that the smallholder on average has two to three heads per farm.

At a global scale, smallholder dairy farmers want to have profitable and sustainable business to secure their livelihood (Moran, 2009). However, farmers facing some challenges to be sustainable. In Africa, the main challenges are the lack of finance, shortage of feed, low price of milk, low performance of milk production, and health problem (Atuhaire et al., 2014; Nkya et al., 2007; Tebug et al., 2012). Those challenges are also happen majority in Asian countries (Moran, 2009). In Indonesia, many studies reported that shortage of capital become the main challenge for smallholder dairy farmers to be sustainable (Tawaf and Surianingrat, 2010; Sembada et al., 2016). In addition, majority of the farmers also have problem with waste management (Devendra, 2001) that might affect the sustainability of smallholder dairy farming system.

The concept of sustainability evaluation in agriculture is widely proposed by many researchers. López-Ridaura et al., (2002) proposed a MESMIS framework to evaluate the sustainability. The sustainability is defined by seven attributes: productivity, stability, reliability, resilience, adaptability, equity, and self-reliance. To evaluate sustainability of farming system, we clearly need to identify the critical points, the diagnostic criteria and the strategic indicators. The critical points are the aspects that enhance or constrain system's attributes. These might be also the social, environmental, or/and economic nature. These factors have a critical and important impact on the future or survival of the management system. The diagnostic criteria is a link between attributes, critical points, and strategic indicators. After the selection of criteria, we can develop the strategic indicators to evaluate the sustainability of farming system.

We conducted a study in Subang and Bandung Barat district, West Java Province to understand which farms and why some farms have a better sustainability at one or another dimension. We selected the study areas because those are the main work areas of an

important milk cooperative in Indonesia. This study focused on evaluating the sustainability of smallholder dairy farming system. We also identified the factors explaining the levels of the sustainability by describing the structure, the practices, and the technical-economic performance of the farms.

METHODS

Study site

We selected two study areas in West Java Province, including Subang and Bandung Barat district. Subang is a highland with altitude between 500 – 1500 m. The activities generating income are mainly tea plantation, tourism (hot spring water), crop land and livestock. The population density is around 620 inhabitants/km² in 2013 (Badan Pusat Statistik Kabupaten Subang, 2014).

Lembang in Bandung Barat district is a high plateau with altitude more than 700 m. The main activities are agricultural sector (29%), trading sector (21%) and others. Land use included rice field (3%), non rice field (71%) and non agricultural land (26%) (Badan Pusat Statistik Kabupaten Bandung Barat, 2015). More than 16000 dairy cows were managed by farmers in this area. The farmers are members of the milk cooperative (*Koperasi Peternak Sapi Bandung Utara - KPSBU*).

Research Design

We carried out a study from May 2015 to May 2016. To understand in what condition farms are more sustainable, we performed a descriptive and comparative study.

In the present, we adapted MESMIS framework to develop the indicators of sustainability. López-Ridaura et al., (2002) proposed this framework to evaluate the sustainability of complex socio-environmental system. Several studies applied and validated this framework to evaluate sustainability in agriculture farming system (Astier et al., 2012; Barbier and Lopez-Ridaura, 2010; Speelman et al., 2007), livestock farming system (Astier et al., 2012; Gaspar et al., 2009; Salcedo and García-Trujillo, 2005) as well as dairy farming system (Ripoll-Bosch et al., 2012; Toro-Mujica et al., 2014). We adapted this framework due to the available data and the comprehensive method.

We collected primary data in indepth-interviews with experts and farmers to identify relevant indicators of the sustainability (Table 11). Then, the experts judged the score of the importance level for each relevant indicators (Table 12). Then we conducted a formal farm survey and direct observation to evaluate sustainability based on selected indicators. From the evaluation of selected indicators, we built the pattern of sustainability. Furthermore, we compared the sustainability of each pattern and identified factors explaining the differences. To complete information, we collected secondary data from KPSBU and public authorities.

The idea was to have an assessment of the sustainability based on a few indicators to simplify the analysis. The aim of the analysis was to understand why and how some farms are more or less sustainable according to their structure, the choice of functioning and the technical and economic performance. We adapted the literature review and the main important and strategic indicators to assess the sustainability for each pillars (Table 12). Selected indicators were total income per family worker (economic viability), willingness to continue the dairy farming activity (social sustainability), waste management (environmental sustainability), own land per family worker, herd size per family worker, and diversity of activities (vulnerability).

Table 11 The attribute, critical points, criteria and indicators of sustainability of dairy farming system in study areas

Attribute	Critical point	Criteria	Indicator
Self reliance	Land limited	Physical capital	Land ownership
Adaptability	Low income resources	Economic activities of the family	Number of activities
	Low level of education	Family welfare	Level of education
Equity	Generation of fix labor	Employment generation	Percentage of fix family labor
	Abandon of farm	Continuity	farmer's will to continue dairy business by their children in the future
	High dependancy on the activity	Economic activities of the family	contribution of dairy activity to their total income
	Low labor productivity	Productivity of labor	Percentage of dairy income per total expenses herd size per worker Total land used per worker
Stability, reliability, resilience	High dependancy on external resource	Forage production	Forage area per total land used total forage production per year per herd size
	Low biological diversity	Water resources Species	Additional water resources Number of species
	Low concern of farm waste	Waste management	Waste management at farm
	Productivity	High economic vulnerability of activity	profitability	Net dairy income (KPSBU) per labor per year Net dairy income (KPSBU) per land used per year Net dairy income (KPSBU) per milk sold per year
Inadequate management of resources use		intensification	Milk sold to KPSBU per month per total land used
			Milk sold to KPSBU per month per Animal Unit

Table 12 Indicators and its level of importance from three pillars of sustainability of dairy farming system in study areas

Pillars	Indicator	Unit	Level of importance ¹
economic	number of activities generating income		3,50
economic	net dairy income (KPSBU) per worker per year	IDR/Person/year	3,50
economic	net dairy income (KPSBU) per total land per year	IDR/ha/year	3,17
economic	net dairy income (KPSBU) per milk sold per year	IDR/Liter/year	3,50
economic	milk sold per herd size	Liter/AU/month	3,50
economic	share of dairy income from total income	%	3,33
economic	Percentage of dairy income per total expenses	%	n.a.
economic	land ownership (own land/total area)	%	3,00
Social	education level		2,83
Social	fix family labor per total labor	%	3,33
Social	farmer's will to continue dairy business by their children (no= 0; yes=1; up to them=2)		3,50
Social	worker per herd size	Person/AU	3,17
Social	worker per total land	Person/ha	2,67
Environment	forage land per total land	%	3,33
Environment	Additional water resources (no=0; yes=1)		n.a.
Environment	Forage land per herd size	ha/AU	3,00
Environment	number of species		2,50
Environment	milk sold per total area	Liter/ha/year	2,33
Environment	Waste management	Score (1-3)	3,42

Sampling

Milk producers in Subang and Bandung Barat district are the active members of the milk cooperative (KPSBU) which comprised more than 4000 farmers in 2015. Our survey covered a total of 355 farms and randomly chosen among all TPS (*Tempat Penampungan Susu*-milk collecting point). According to the officer of KPSBU, new dairy farmers who started dairy farming activity since 2007 are dominant in Subang district. Otherwise, in Bandung Barat, majority of farmers had more experience in dairy farming activity.

Information taken into account

To describe farms in the study sites, we collected the information about farmer's socio demographic characteristic, structure and dairy farming practices. Farmer's socio demographic characteristic covering the age of farmer, experience in dairy farming, and their level of education. Farm structure included herd size and land use. In addition, dairy farming practices were quantity of feed concentrate and forage.

We obtained the information of sustainability indicators, including total income per family worker (economic viability), willingness to continue the dairy farming activity (social sustainability), waste management (environmental sustainability), own land per family worker, herd size per family worker, and diversity of activities (vulnerability). Those were the most important indicators considered by stakeholders.

Score of sustainability was from 0 to 100 (Table 13). Each selected indicators have different way to obtain the score of sustainability. For scoring the economic pillar, we considered minimum wage and poverty line. The higher total income was considered as higher score of this pillar and higher level of sustainability as well. Total income was defined as [Total income = Net dairy income + Net income from other activity]. To obtain score of social pillar, we considered three modalities concerning farmers expect their children to continue dairy business. The modalities are: (i) no (low score); (ii) up to them (medium score); (iii) yes (high score). For scoring of environmental pillar, we estimated from their waste management practices. If farmers did not evacuate waste to rivers or surrounding area, it was considered as high score sustainability.

We adapted other ways to obtain the score of vulnerability of family farm (own land, herd size per family worker and diversity). The higher score means less vulnerable farm. We considered data distribution for two indicators, including own land per family worker and herd size per family worker. For the scoring of diversity indicators, we proposed two hypotheses: i) higher is the number of activities, higher is the sustainability, ii) the more balanced activities – in term of contribution to total income – higher is the sustainability. In study areas, we identified three main activities generating income included dairy business, crop farming activity and off farming activity. When there is only one activity, the sum $\sum_1^3 (xi - \frac{100}{3})^2$ is equal to 6667. It corresponds to the more vulnerable situation. When there are three activities, each of them contributing to 100/3 % of the total income the sum $\sum_1^3 (xi - \frac{100}{3})^2$ is null. It corresponds to the less vulnerable situation (three activities with balance contribution).

The information taken into characterized account farms were divided into four categories adapted from Sembada et al., (2016): (i) structure, (ii) dairy farming practices, (iii) technical-economic performance, and (iv) feeding system. The farm's structure included the total land use (owned and rented), contribution of owned to total land, number of workers, herd sizes, and number of lactating cows. Dairy farming practices including daily quantity of green forage, dry matter of concentrate calculated using the national standards (Badan Standardisasi Nasional, 2009), and working hour.

Technical-economic performance including the quantity of milk sold to cooperative, milk productivity per cow, milk productivity per herd size, net dairy income, and contribution of dairy income to total income. Net income was defined as [Net Income = Total milk sales + Cows sales + Calves sales + Manure sales – (Cost of feed + Cost of vet services + Financial cost of credit reimbursement + Cost of hired labor + Cost of rented land)]. We estimated total milk sales from data provided by KPSBU. Feeding system including the utilization of feed forage, concentrate, tofu and cassava waste.

Table 13 Scoring method of six variables of sustainability

Variables	Score	Level of sustain- ability	Modalities
Total income per family worker	0	Low	total income < poverty line
	25	Low to medium	Poverty line < total income < regional minimum wage
	50	Medium	Total income is one to two times of regional minimum wage
	75	Medium to high	Total income is two to three times of regional minimum wage
	100	High	Total income is more than three times of regional minimum wage
Willingness to continue the dairy farming activity (social sustainability)	0	Low	farmers do not want their children to continue dairy business
	50	Medium	farmers let their children choose whether to continue dairy business or no.
	100	High	farmers surely want their children to continue dairy business
Waste management	0	Low	farmers evacuate all waste to river or surrounding area
	50	Medium	farmers still evacuate part of waste to river or surrounding area but some part others are processed to be biogas or fertilizer
	100	High	Farmers do not evacuate waste to river or surrounding area (main point), farmers process waste to be biogas and or fertilizer.
Own land per family worker	0	Low	Own land < Quartile 1
	50	Medium	Quartile 1 < Own land < Quartile 3
	100	High	Own land > quartile 3
Herd size per family worker	0	Low	Own land < Quartile 1
	50	Medium	Quartile 1 < Own land < Quartile 3
	100	High	Own land > quartile 3
Diversity of activities	0	Low	$Score = 100 - \left(\sum_1^3 \left(xi - \frac{100}{3} \right)^2 * 100/6667 \right)$ <i>With:</i> <i>xi = contribution to the total income of the activity x</i> <i>6667 = maximum value when there is only one activity</i>
	50	Medium	
	100	High	

Data analysis

The aim of the analysis was to understand which and how some farms are more or less sustainable according to their structure, the choice of functioning the technical and economic performance. We conducted three steps of analysis. First, we performed a descriptive analysis to describe farms in study area including farms' socio demographic characteristic, structure and dairy farming practices. Second, we calculated a score of sustainability for six indicators and built the pattern of sustainability to identify which farm have better sustainability than others. In this step, we performed multivariate analysis (PCA and cluster analysis) (cf annex 3) for six indicators to build the pattern of sustainability. Third, we performed comparative and descriptive analysis based on the pattern of sustainability. In this step, we performed ANOVA, Tukey's test ($\alpha = 0,05$) and descriptive analysis for some variables (structure, dairy farming practices, technical-economic performance, and feeding system). From this analysis, we could understand why some farms have a better sustainability for one or another dimension of the sustainability.

RESULTS

Description of dairy farms in the study areas

Table 14 represents the description of farm in the study areas based on their socio-demographic characteristic, structure and practices. On average age, the farmers were 42 years old. Farmers' experience vary between 2 to 47 years in dairy farming. The farmers' education level was low. More than half farmers attended only elementary school (Table 14). On average, farmers only had three to four cows (3,9 AU per farm). Cows were from Friesian Holstein which were mated with local breed since a half century ago. In Indonesia, dairy cows were mostly kept in tie-stall barn and were fed through cut and carry system. On average, total 45 kg of green fodder were given to the cows per day. Dairy farmers accessed 0,3 hectare per farm which is mostly cultivated with napier grass. The quantity of concentrates was around 6 kg of concentrate per cow a day.

Table 14 Farm description in study areas

Variable	Mean \pm SD (n =355)	Min.	Max.
Farmer's socio-demographic characteristic			
Age	42 \pm 11.6	21	70
Experience in dairy farming	12.9 \pm 8	2	47
Level of education			
Bachelor degree	3	-	-
High school	27	-	-
Junior high school	64	-	-
Elementary school	261	-	-
Structure			
Herd size (AU/farm)	3.9 \pm 3	0.5	27.3
Land use (ha/farm)	0.34 \pm 0.42	0.003	3.4
Practice			
Quantity of concentrate	5.9 \pm 2.8	0	16.3
Quantity of green forage	44.9 \pm 21.3	0	125

Source: survey (2015)

Sustainability pattern

We identified five patterns of the sustainability. The characteristic of each pattern was variable. Pattern 1 (P1) was related to very small and diversified farm. Pattern 2 (P2) was small specialized dairy farm with children want to continue dairy business. Almost similar with P2, Pattern 3 (P3) was also small specialized dairy farm but without children want to continue dairy business. Pattern 4 (P4) was intensive and small specialized dairy farm. The characteristic of Pattern 5 (P5) was small diversified farm.

The result indicated that P4 and P5 had medium to high score of sustainability for almost all indicators. Compared with others, those pattern had the highest score. P5 had higher score of sustainability and significantly different for almost all indicators except economic pillar (48) and herd size per family worker (62). In term of income (economic pillar), P5 had on average one to two times of minimum wage which resulted medium

score of sustainability. In addition, P5 had better waste management (environment pillar) because they processed waste to be fertilizer or biogas and did not evacuate it to rivers. Otherwise, P4 had the highest score of herd size per family worker than other patterns. It enable them to generate more income from dairy business. However, they have higher risk from dairy farming activity than P5. We then considered P5 as the most sustainable smallholder dairy farming system due to the more balance for all indicators than P4 (Table 15 and Figure 27).

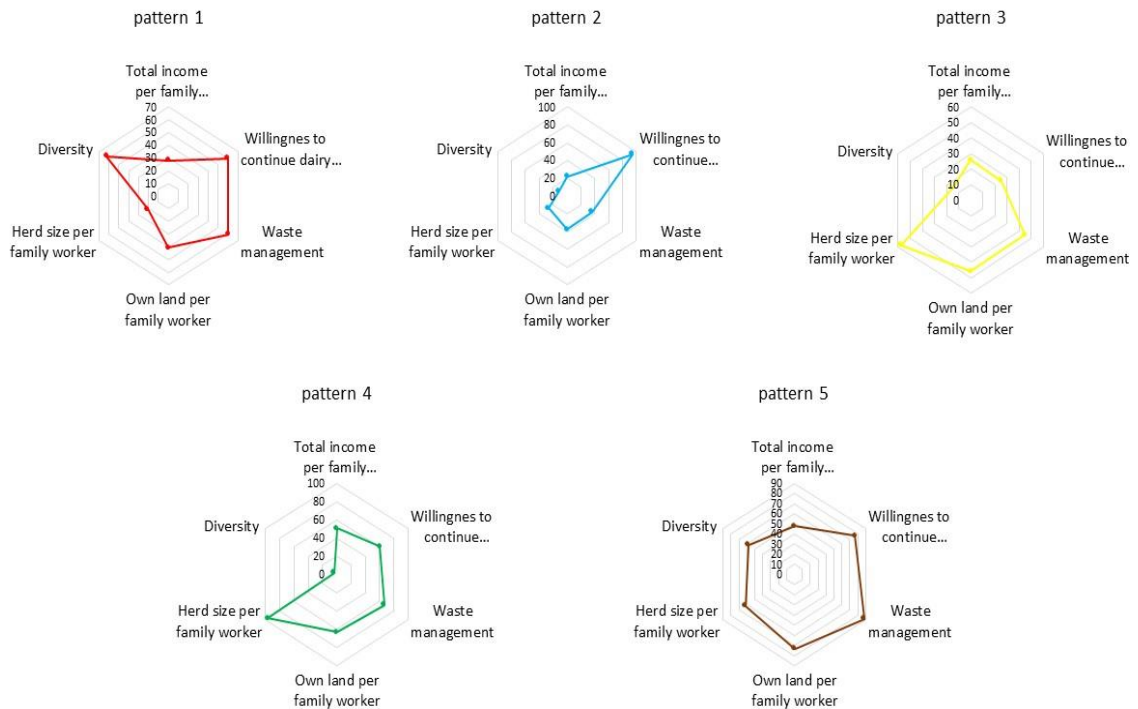
Table 15 Pattern based on sustainability score (1-100)

Variables	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
Total income per family worker	27,9 ± 12,2 ^B	21,6 ± 12,6 ^B	25,9 ± 16,2 ^B	50,4 ± 29,7 ^A	47,8 ± 23,7 ^A
Willingnes to continue dairy business	59,7 ± 28,1 ^C	94,4 ± 15,9 ^A	25 ± 25,2 ^D	60,8 ± 27,8 ^C	76,7 ± 25,2 ^B
Waste management	60,4 ± 31,8 ^B	36 ± 36,9 ^C	44,6 ± 35,6 ^C	66,7 ± 36,4 ^B	87,8 ± 21,7 ^A
Own land per family worker	40,9 ± 36 ^B	37,6 ± 35,6 ^B	45,8 ± 34,9 ^B	63,3 ± 30,4 ^A	73,3 ± 25,2 ^A
Herd size per family worker	20,8 ± 24,8 ^C	27 ± 26,2 ^C	57,7 ± 22,6 ^B	96,7 ± 12,6 ^A	62,2 ± 28,5 ^B
Diversity	62,6 ± 16,5 ^A	11,7 ± 20,4 ^{BC}	15,5 ± 26,9 ^B	3,7 ± 7,8 ^C	58,1 ± 19,2 ^A

Means in the same column with a different superscript differ significantly ($P < 0.05$); NS not significant

Source: survey (2015)

Figure 27 Sustainability pattern



The sustainability score of P2 and P3 were the lowest for almost all indicators (Table 5 and Figure 1). Farms in those patterns were less sustainable than others. Farmers at P2 only had less than 25 (low score of sustainability) for economic pillar and vulnerability. The income from dairy business was even lower than poverty line. Otherwise, their score of social pillar was significantly higher (94). P3 was less vulnerable than P2, meanwhile they had the lowest score in term of social pillar. Majority of farmers did not want their children to continue dairy business.

Characteristically, farmers P1 had the lowest score (20) of the indicator of herd size per family worker. As a response of small herd size and low score of economic pillar, they had another activity generating income to cover daily expenses. It resulted in the medium score of sustainability (62) and significantly higher than other patterns on the indicator of diversity.

Characteristic of farms explaining their score of sustainability

Characteristically, farmers at P4 had better capital and technical-economic performance than other patterns. They had higher land use, herd size, lactating cows and significantly different than other patterns (Table 6). They use more than 4600 m² of land per farm. On average, they had seven cows, of which five were lactating cows. Furthermore, for feeding practice, farmers fed the cows with an average 35 kg of forage and 5.5 of dry matter concentrate per cow per day. Even though quantity of forage was significantly lower than other patterns, they still had better technical-economic performance. Farmers sold almost 1800 liters of milk per month to cooperative. In a year, they received on average more than 50 million IDR per farm. It was significantly higher than others. Lower input resulted better performance. In other words, farmers P4 could manage their farms efficiently.

Diversified activity was a main difference between P4 and P5. Farmers P5 had also higher capital, practices, and technical-performance than other patterns which was the 2nd highest after P4. However, dairy business contributed only 65 percent. In other words, farmers P5 had other activity generating income. Quantity of feed even higher than farms at P4. It was because they used paddy straw and other crop residu for forage feed from their additional activity such as crop farming activity.

Majority were farms P2 and P3 (Table 16). Generally, they had low capital and technical-economic performance. On average, they had two to three cows per farm. However, total workers on farms P2 was significantly higher than others. Meanwhile, P3 had the lowest total workers. The net dairy income on average was 1.8 to 1.9 million IDR per month (equivalent to US\$ 139 to 144 per month¹). Majority of farmers at those patterns were specialized in dairy business which generate more than 80 percent of total family income.

Table 16 Structure, dairy farming practices, and technical-economic performance of dairy farm

Variables	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
Structure					
Total land (m ²)	3060 ± 3440 ^{AB}	2620 ± 2810 ^B	3190 ± 3790 ^{AB}	4660 ± 5700 ^A	4580 ± 5470 ^{AB}
Contribution of own land to total land (%) ^{NS}	40,1 ± 41,2	51,2 ± 43,8	43 ± 40,6	50,1 ± 40,3	54,3 ± 35,8
Total workers (person)	2,1 ± 0,6 ^{AB}	2,2 ± 0,7 ^A	1,9 ± 0,7 ^B	1,9 ± 0,9 ^{AB}	1,9 ± 0,7 ^{AB}
Herd size (LU)	2,3 ± 1 ^D	3 ± 1,6 ^{CD}	3,8 ± 1,7 ^{BC}	7 ± 4,8 ^A	4,3 ± 3 ^B
Lactating cow (LU)	1,7 ± 0,8 ^C	2,2 ± 1,5 ^{BC}	2,8 ± 1,5 ^B	5 ± 3,6 ^A	3 ± 2,2 ^B
Dairy farming practices					
Quantity of forage (kg/cow/day)	53,1 ± 23,3 ^A	44,1 ± 19,6 ^B	45,1 ± 20,7 ^{AB}	34,5 ± 17,3 ^C	46,5 ± 21,2 ^{AB}
Quantity of concentrate (Kg DM/cow/day) ^{NS}	5,5 ± 3	6,1 ± 2,8	5,9 ± 2,8	5,5 ± 2,8	6,3 ± 3
Working hours (hours/farm/day) ^{NS}	9,6 ± 5,1	10,6 ± 4,8	10,3 ± 4,2	11,7 ± 6,6	10 ± 4,7
Technical-economic performance					
Milk sold to cooperative (liters/farm/month)	640 ± 332 ^B	733 ± 480 ^B	862 ± 433 ^B	1782 ± 1413 ^A	994 ± 713 ^B
Milk productivity (liters milk sold/LU/day) ^{NS}	9,5 ± 4,1	8,5 ± 3,3	8 ± 3,2	8,5 ± 3,9	8,4 ± 3,9
Milk productivity per lactating cow (liters milk sold /lactating cow/day) ^{NS}	12,5 ± 4,4	12,2 ± 5,9	11 ± 4,3	12,3 ± 5,9	11,8 ± 4,7
Dairy income (million IDR/farm/year)	20,9 ± 14 ^B	23 ± 21,1 ^B	22 ± 20,1 ^B	51,9 ± 59,5 ^A	31,8 ± 19,9 ^B
Contribution dairy income to total income (%)	58,9 ± 21,4 ^B	85,6 ± 29,3 ^A	82,1 ± 31,5 ^A	88,7 ± 29,9 ^A	64,8 ± 21,2 ^B

Means in the same column with a different superscript differ significantly (P<0.05); NS not significant

Source: survey 2015

Note: 1 US\$=13385 IDR in August 2017

P1 also had low capital and technical-economic performance. In term of herd size, farmers P1 had the lowest capital than others. They had less than three cows, of which two were lactating cows (Table 16). Due to their smaller size of herd, farmers fed the cows with an

average 53 kg per cow per day and it was significantly higher. In addition, the milk productivity per cow was slightly higher but no statistical difference. Higher input (forage feed) resulted only slight higher milk productivity. In other words, it indicated less efficient than P4. Furthermore, dairy business only contributed less than 60 percent to total income. Farmers did not only depend on this activity to generate income. Diversified activity was a response to face their limitation of low capital and low dairy business performance.

Feeding system

All cows were fed with green forage (cut and carry system) which was mainly napier and natural grass, and in zero grazing system. As a member of cooperative, farmers purchased concentrate feed from milk cooperative. Majority of farmers mixed concentrate with tofu and or cassava waste as well as water. Feeding time was two to three times a day. Farmers provided water to the cows through ad libitum, twice a day or even only once a day.

Majority of farmers produced forage on their land (owned and rented). They also purchased tofu or cassava waste (Table 17). However, some farmers purchased all feed (forage, tofu, and cassava waste) particularly those who were located in the center of city. They could not access land for forage production due to high price of land. In addition, land was mostly for housing.

Table 17 Link between feeding system and pattern of sustainability (number of farm)

Feeding system	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
1 (n = 48)	9	17	9	7	6
2 (n = 219)	51	47	54	37	30
3 (n = 15)	1	6	3	4	1
4 (n = 73)	16	19	18	12	8

1 = only produce forage, no additional tofu or cassava waste; 2 = produce forage, purchase tofu or cassava waste; 3 = purchase forage, no additional tofu or cassava waste; 4 = purchase forage, tofu, and cassava waste

DISCUSSION

Our result confirmed that capital plays a key role to promote the level of sustainability in particular economic pillar. Higher capital such as herd size, land access, and know-how might resulting high technical-economic performance. Higher asset (land and herd size) enable farmers to produce more milk and calves to have better income (Lebacq et al., 2015). It then hence the higher sustainability.

Our result indicated that diversified activity also plays an important role not only to reduce risk of dairy business (uncertainty of milk price and input price) but also to have the synergy between activities. However, our result is different with a study conducted by Khanh et al., (2017) that mentioning specialized dairy farms have lower production costs, and hence higher economic sustainability. In the study sites, farmers used paddy straw from their crop land to reduce cost of feed and used manure from dairy farm to be organic fertilizer. The efficiency is higher. It is explaining why farms in P5 were considered as more sustainable dairy farm than in P4. Eventhough, P4 had better capital but they were specialized in dairy that might have higher risk in the future such as instability of milk price and input price. Otherwise, P5 had strategy to diversify their activity generating income. More diversified farming system enable farmer to get more total family income by using available time and family worker. Farmers can use resource optimally (Gaspar et al., 2009; Lebacq et al., 2013; Ryschawy et al., 2013). The result underlines the specificity of small-scale family agriculture that needs to be able to switch from one activity to another in case of crisis or problem. Or this underlines the fact that total farm income must be considered (instead of partial dairy margin) (García-Martínez et al., 2011; Ripoll-Bosch et al., 2012).

Majority of farmers accessed land of State Forestry Enterprise (*Perhutani*) (Figure 28) or of State Tea Plantation (*Perusahaan Terbuka Perkebunan Nusantara/PTPN*) (Figure 29). It is a kind of land use right / arrangement which is formal (in the case of forestry) and informal (in the case of Tea Plantation). Since 2001, Perhutani invited community at the surrounding area to manage forest (*Pengelolaan Hutan bersama Masyarakat-PHBM*). This community based forest management allow farmers surrounding area to cultivate grass on forestry land. There is also a tolerance from tea plantation as long as farmers

only cultivate grass. However, this arrangements are fragile and uncertain. In addition, the infrastructure and location are not comfortable. It takes time and energy or even needed additional worker to get the forage from this location. This is why to own the land is so important in the sustainability indicator. It is also important to increase efficiency of dairy business (Lebacq et al., 2015). It can reduce cost of feed or hire outside worker.

With regard to the social pillar, the result showed that P3 had the lowest score of sustainability. Majority of farmers expect their children to have other activity. Due to their small size of herd and land, dairy income generate less than minimum wage. Some studies reported that economic is linked with social pillar (Lebacq et al., 2013; Van Cauwenbergh et al., 2007). In addition, they only focused on dairy business. It is more vulnerable. Otherwise, P2 who also had same characteristic with P3, but they had the highest score of sustainability in social pillar. It is related to high availability of workers. They had no choice to convert to other activity.

Figure 28 Forestry land owned by Perhutani that can be accessed by dairy farmers



Figure 29 land of PTPN for tea plantation (a) and unused land that is accessible for farmers



(a)

(b)

In term of environment pillar, it was explained by capital (owned land) and total income. Farms which had larger size of owned land and higher total income, they also had higher level of environment pillar. It is in line with study reported by Lebacq et al., (2015). Majority of farmers received biogas equipment and installation from dairy development project by cooperative, NGO, government and others (Figure 30). They obtained it for free, and some others by credit scheme through dairy cooperative. In other words, every farmers could access it. However, some farmers did not install biogas equipment due to limited space (small size of owned land) at barn. It underlines the importance of owned land to increase waste management practices.

Majority of farmers able to produce forage for the cows. In addition, about 20 percent of farms in P2 did not depend on cassava or tofu waste. Farmers had opportunity to cultivate forage on unused land of PTPN or Perhutani. However, in the future they will have uncertainty since PTPN and Perhutani would convert those land to cultivate horticulture and to be tourism area. In other words, input self sufficiency (particularly feed) has an important role to promote sustainable farming system (Lebacq et al., 2015; López-Ridaura et al., 2002; Ripoll-Bosch et al., 2012).

As a conclusion, working capital and diversity play an essential role to promote sustainability. Increasing know-how (human capital) is also important to enhance

performance. Farms with higher capital will be more sustainable due to generate better technical-economic performance. This enhancement affected the indicators of sustainability. In addition, diversity could reduce the risk from only one activity generating income. Farmers will be less vulnerable. It might resulting the more balance of sustainability. We indicated that increased working capital and diversity can boost the level of the sustainability of smallholder dairy farming system.

Figure 30 Biogas installation in the farm



Synthesis of the chapter

To evaluate the sustainability, we identified some indicators based on the literature review, the in-depth interview. We then selected relevant indicators from three dimensions to evaluate the sustainability in the study site. We carried out a formal survey covered to 355 farms to evaluate the sustainability from those indicators as well as other indicators to explain why farms are better in some dimensions.

The chapter clearly shows that there are five patterns of sustainability in the study site. The characteristic vary of each pattern. Pattern 1 (P1) was very small and diversified farm. Pattern 2 (P2) was small specialized dairy farm with children want to continue dairy business. Almost similar with P2, Pattern 3 (P3) was also small specialized dairy farm but without children want to continue dairy business. Pattern 4 (P4) was intensive and small specialized dairy farm. The characteristic of Pattern 5 (P5) was small diversified farm.

We identified some main findings. First, the most sustainable was farms which had higher capital and diversified activity (farms pattern 5). Second, low capital but with an additional activity (pattern 1) were more sustainable than specialized farms (pattern 2 and 3). Third, the level of capital and the diversification of the activities on farm both play important roles in the sustainability of the farms. Higher capital can generate higher technical-economic performance as well as promote higher sustainability. Meanwhile, the diversity can play a key role to reduce risk from dairy business.

This chapter plays a key role to understand the sustainability of dairy farming system in Indonesia from a static analysis. However, to better response the research question of the thesis, further study is needed in particularly to understand the dynamic at farmers' level. The following chapter presents: the understanding the farmers' strategies in the development of dairy production in Indonesia.

CHAPTER 3

CHAPTER 3. Understanding farm trajectories in the development of dairy production in Indonesia: case study in West Java Province

Chapter's Introduction

In the previous chapters, we could answer and confirm the first sub-question “what are the condition of dairy farming system in the perspective of sustainability?”. Those chapters underlining the importance of the capital and diversified activity to promote higher level of sustainability. To have the complete responses of the thesis research question: “in what condition smallholder farms will be sustainable in the future?”, we carried out a further study.

This chapter presents a dynamic assessment at the farmers' level. The study aimed at understanding the farmers' strategies and drivers to face their limitation. It also allows us to identify the changes in milk production system in Indonesia. Furthermore, we could understand the strategies at farmers' level in the development of dairy production in Indonesia. It is important to make such reflexion concerning the farm model in national dairy development. This chapter could answer the thesis sub-questions” what are the farm trajectories in the development of dairy production?” and “what dynamic in milk production system in Indonesia?”.

The previous chapters could help us on selecting farmers for trajectory analysis. First, from the big sample we built the typology of farm. From each type of farm, we compared its productivity and economic performance. Then, we selected some farmers as representative from each type of farm. We carried out trajectory analysis for those selected farmers.

In our hypothesis there were different strategies at each type of farm to make them sustainable. The model of dairy farm will affect the national dairy development.

This chapter will be submitted to a scientific journal, after a final improvement following the defence of the thesis.

**Understanding farm trajectories in the development of dairy production in Indonesia:
case study in West Java Province**

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ABSTRACT

In Indonesia, smallholders dairy farm play a key role in the economic development of rural areas. However, farmers face some limitation to develop dairy production. They respond differently to overcoming the constraints of production factors. To understand the strategy in the development of dairy production in farmers' level to ensure income and to provide national market, we conducted a study in West Java Province. We collected informations into two steps included formal survey from May to September 2015 and in-depth interview from January to April 2017. First step, we carried out a formal survey which covered total of 355 farms to build farm typology and to characterize each type of farm. Second, we conducted two times in-depth interview to 20 farms which represented of each type to understand their farm trajectory. Our result indicated that the net dairy income increases according to the herd size. Around 55 percent of farmers who have three cows, reached income treshold. We also identified four types of farm including very small specialized dairy farm (T1), dairy farm with an off farm activity and with very limited land (T2), small specialized dairy farm (T3), and mixed crop-dairy farm (T4). The technical-economic performance vary according to the type of farm. The 6 trajectories exist in the study area. The main dynamic was to add off farm activity for poor farmers as a response to face their limitations or abandon off farm activity due to limited family worker. Another dynamic is the increase of herd size for the specialized farm with higher working capital. Meanwhile, diversified farm (crop-dairy business) enlarged land access but relatively stable for the herd to manage both activities proportionally. Even though, T3 might play a key role to the milk market, but focusing only on this type for national production could not be relevant because the difference of size between producers is not too much. It underlines the importance of understanding farm trajectories to design appropriate policy for the development of dairy production.

Keywords: smallholder, trajectories, dairy production

INTRODUCTION

Smallholders are defined as small-scale farmers who are characterized by using mainly family labour, traditional farming systems, and low-resource agriculture for commercial production as well as for family consumption (Altieri et al., 2008). In Indonesia, decree No. 404/Kpts/OT.210/2012 of Minister of Agriculture mentioned that smallholder farm is a side business activity which is characterized by small-scale farm with a maximum size differently according to their animals (for instance, the maximum is 20 cows for dairy farm).

Smallholder dairy farms play a key role to contribute in economic development in rural areas. Totally, they hold 92.6 percent of total dairy cattle population (Badan Pusat Statistik, 2013; Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2016)). Smallholder dairy production generates income and creates job opportunity for more than 150 thousands households. However, smallholder farms face some difficulties in particular limited production factors (herd size, feed, workers and land access) which results in limited family income (Poulton et al., 2010; Sembada et al., 2016). On average, small farmers only manage 2.9 dairy cows per household (Badan Pusat Statistik, 2013). In addition, the high number of producers who have less than four cows could only contribute for around 64 percent of national milk production (Muzayyanah et al., 2013). Limited capital might cause a problem on the development of dairy production at farm level to ensure income as well as to provide the national dairy market.

Smallholder dairy farms respond differently to these constraints in order to ensure family income. Outside Indonesia, some farmers adapt through diversification by adding on-farm activity (García-Arias et al., 2015; Meraner et al., 2015) and off-farm activity (Barrett et al., 2001; García-Arias et al., 2015). Some others get more and more specialised in milk production in order to benefit from economies of scale and improved know-how. Some others choose to abandon dairy business (García-Arias et al., 2015). Those strategies might affect the development of dairy production at farm level as well as national level.

To understand the effects of farmer's strategies on the development of dairy production to ensure family income and to provide milk to the national market in Indonesia, we conducted a study in West Java Province. The present study focused on identifying the different types of farm, describing their characteristics and basic performances, as well as drawing farm trajectories.

We selected this province because of its high population of dairy farmers and dairy cows, good access to market, and suitable location for milk production. West Java Province is the second largest of dairy cow population and milk production in Indonesia : it produced 30 percent of national milk production in 2016 (Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2016). In addition, the main milk cooperative (KPSBU) is located in this province specifically in Bandung Barat District and Subang District. According to cooperative officers, this cooperative has around 4,000 members who are smallholder farmers who manage totally around 16,000 cows. Furthermore, this cooperative has the highest milk production level which is for around 140 thousand tons of milk per day. Through this cooperative, farmers have good access to milk market as well as to feed and other inputs. Lastly, the study area has cool wet climate which is environmentally suitable for dairy cow.

METHODS

Study site

A study was conducted in work area of the North-West Bandung milk cooperative (*Koperasi Peternak Sapi Bandung Utara - KPSBU*), covering Bandung Barat and Subang district. Indonesian government, through decree No.43/Kpts/PD.010/2015 of Minister of Agriculture, assigned Bandung Barat district as a dairy business area. This district has high livestock potential (in particular dairy) due to the cool wet climate. The altitude is more than 700 m with an average monthly rainfall of around 160 mm per month. In 2015, the density was 1,280 inhabitants per km² and of around 24 percent worked in agricultural sector. The population of cows were more than 26,000 cows, which majority belonged to members of milk cooperative KPSBU (Badan Pusat Statistik Kabupaten Bandung Barat, 2016). Farmers have long time experience in the dairy business.

Subang district cover 2,050 km² which around 20 percent is highland (500 – 1500 m). Agricultural sector play an important role in gross regional domestic product which contributed 27,5 percent in 2015 (Badan Pusat Statistik Kabupaten Subang, 2016). Three sub-districts in Subang are work area of KPSBU included Ciater, Sagalaherang, and Jalancagak (in the border of Bandung Barat district) which hold more than 80 percent of total population of dairy cows. Dairy activity progressed rapidly, when KPSBU in partnership with private company extended their work area to those sub-districts since 2007 in order to increase milk production.

The main difference between Bandung Barat district and Subang district for study area is related to the experience of the farmers and the plantation. Bandung Barat is near from forestry land of Perhutani and housing area but Subang is near from tea plantation from PTPN (state tea plantation). In addition, on average the experience of farmers on dairy business in Bandung Barat is longer than in Subang.

Sampling

A total 355 out of 4000 milk producers in work area of KPSBU were surveyed. They were randomly chosen among all sub-district milk collecting points (*Tempat Penampungan Kecamatan-TPK*). KPSBU has totally 25 TPK. Each TPK consists of around 10 small milk collecting points (*Tempat Penampungan Susu-TPS*). Farm types then were performed using this data survey. Furthermore, to clearly understand the dynamic of farms, the in-depth interviews covered a total 20 out of 355 farms randomly selected among farm types.

Data Collection

The data were collected through a formal survey (cf annex 2) on May to September 2015 to identify the characteristics of farms in the area. Furthermore, in-depth interviews with farmers were conducted on January to April 2017 to understand the trajectory of each farm type. In addition, secondary data from KPSBU and public authorities were collected.

Information taken into account

We collected information from farmers and the cooperative to identify the characteristic and the diversity of the farm, included number of workers, herd size, in Livestock Unit (LU), number of lactating cow, land access (owned and rented), land for forage production, net income (from dairy business, crop farm, and off farm activity). Net income is important to identify the contribution of each activity to total income. Net dairy income was defined as [net dairy income = milk income coop + additional product (cows, calves, manure sales) – cattle purchase – additional feed cost (tofu and cassava waste). Milk income coop was the product of the milk sold to cooperative minus the inputs purchased at the cooperative (feed concentrate, AI service, vet services). Annual net incomes from cropping and off farm activities were collected through farmer's justification.

We also identified basic performances and productivity of the farming system : total net income per farm, total net income per family worker, net agricultural income per land unit, and net

dairy income per LU. To have a better view of the building of the net dairy income per LU, we considered daily milk yield per LU, milk income from cooperative per LU, feed concentrate cost per LU, additional dairy income per LU and additional costs per LU.

Several studies related to farms trajectories have been conducted throughout countries to understand how farmers adapted to changes. Generally, the types of approaches according to Madelrieux et al. (2014) and Dedieu (2009) consists of: compares system states between date-to-date (García-Martínez et al., 2009); across a multi-date timeline (Ryschawy et al., 2011); and focus on the processes of change (Moulin et al., 2008). In the present, we identified the farm trajectories of 20 farms by performing a method proposed by Moulin et al., (2008) to analyze the different strategies of maintaining a dairy activity among type of farm. A similar study has been conducted by Begon et al., (2009) using this approach.

To identify the farm trajectories, from the interview carried out with each farmer (cf annex 6), we extracted information including activities generating income, herd size and land access at the beginning of dairy business and the current situation. We selected those variables because those are important to understand the dynamics in our study context. From those information, we built qualitative variables, with modalities indicating the dynamics between the beginning of the dairy activity and nowadays, as proposed by Malanski et al., (2017), analysing pathways of employees' work on dairy farms. For the off farm activities, we considered the modalities: 1) no off farm activities; 2) abandoning off farm activities; 3) starting off farm activities; and 4) keeping off farm activities from the beginning. The modalities of cropping included: 1) no crop; 2) keeping crops from the beginning. The modalities of herd size included: 1) low increase, with an annual growth rate below 10 percent, and no more than 3 LU in 2017; 2) high increase, more than 10 percent of annual growth rate, and no more than 3 LU in 2017; 3) high increase and more than 3 LU in 2017; 4) more than 3 LU from the beginning and no increase of herd size. In term of land access, the modalities are: 1) low land access at the beginning without increase; 2) low land access at the beginning with increase; 3) higher land access at the beginning without further increase; and 4) higher land access at the beginning with further increase. We also identified the justification given by the farmers to explain their choices when they performed a change in the structure or the operation of their farm.

Data analysis

We performed PCA and cluster analysis (cf annex 4) to identify farm type based on 7 variables included: combination of activities (contribution of dairy, crop, and off farm to total income), balance between the herd and the land dedicated to forage (forage per LU), size of farm and balance between production factors (total land, total workers, herd size). Furthermore, ANOVA and Fisher test ($\alpha = 0,05$) as well as descriptive analysis were performed for 355 farms in order to characterize type of farm and their basic performances by using Minitab 17 Statistical Software.

To identify types of farm trajectories, we carried out a graphical analysis, as proposed by Bertin (1977), and used in similar studies in animal science in order to perform typology (Hostiou and Dedieu, 2012). A cross-table was created with the 20 farms in line and the different variables in rows. The modalities were represented by several shades of colours. Moving lines and rows enabled identifying farms that presented similar visually profiled modalities.

RESULTS

Dairy income and herd size per family worker

The net dairy income increased according to the herd size (Table 18). When there were at least 3 LU per family worker, the net dairy income per family worker reached the value of 27.7 million IDR which is above the threshold corresponding to the average annual salary of an unskilled worker (24 million IDR).

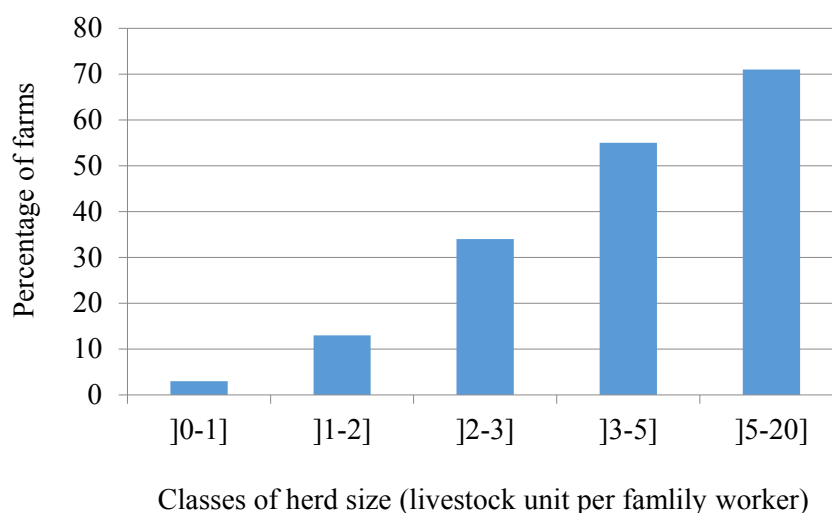
Table 18 Net dairy income par family worker according to the herd size

Herd size ¹	]0-1]	]1-2]	]2-3]	]3-5]	]5-20]
Number of farms	75	140	73	40	21
Annual net dairy income per family worker (million IDR)	9,4 ± 8,2	14,2 ± 9,3	18,8 ± 15,5	27,7 ± 21,0	58,3 ± 65,3

¹ classes of herd size, in number of livestock unit per family worker

Nevertheless, the number of livestock unit detained is not a sufficient condition to reach this threshold (Figure 31). When the number of LU per family worker is between 3 and 5 LU only 55 % of the farms are above the threshold.

Figure 31 Percentage of farms with the net dairy income par family worker above the threshold of the mean annual salary of an unskilled worker according to the herd size



Typology of farm

We identified four types of farm (Table 19). Type 1 (T1) was very small specialized dairy farm. Majority of farmers were in this type which accounted for around 39 percent of the sample. Farmers had very limited access to land (0.13 hectare per farm) and managed 3.5 LU. Type 2 had also a very limited access to land (0.18 ha per farm) but the dairy activity is combined with off farm activities, contributing to 45 percent of the family total income. T3 was small specialized dairy farm. Farmers accessed more or less 0.77 hectare of land per farm. They had on average more than five cows with the highest number of workers (2.2 persons per farm) and the largest area dedicated to forage (more than 0.19 ha per LU). T4 was mixed crop-dairy farm. Farmers conducted two activities generating income (crop and dairy farm). The characteristic of this type is small land access (0.3 hectare per farm) with on average 3.9 LU per farm and a low area dedicated to forage, less than 0.06 ha per LU.

Table 19 Characteristics of the four farm types (mean value and standard deviation)

Farm types	T1 (n=138)	T2 (n=62)	T3 (n=94)	T4 (n=61)
Dairy contribution to total income (%)	96.3 ± 6.6 ^A	53.4 ± 25.8 ^C	85.9 ± 24.7 ^B	42.5 ± 27.2 ^D
Crop contribution to total income (%)	1.2 ± 4.1 ^B	1.5 ± 4.4 ^B	3.6 ± 12.4 ^B	47.6 ± 29.9 ^A
Off farm contribution to total income (%)	2.4 ± 5.7 ^C	45.1 ± 26.8 ^A	10.5 ± 21.4 ^B	9.9 ± 22.2 ^B
Forage land per herd (m ² /LU)	292 ± 294 ^C	725 ± 703 ^B	1907 ± 1824 ^A	541 ± 682 ^{BC}
Total land access (m ²)	1328 ± 1115 ^C	1791 ± 1723 ^{BC}	7735 ± 5586 ^A	3294 ± 2795 ^B
Total workers (person)	1.9 ± 0.6 ^B	1.8 ± 0.6 ^B	2.4 ± 0.8 ^A	2.0 ± 0.7 ^B
Herd size (LU)	3.5 ± 1.6 ^B	2.2 ± 1.0 ^C	5.5 ± 4.8 ^A	3.9 ± 1.8 ^B

Means in the same line with a different superscript differ significantly ($P < 0.05$); NS: not significant

Source: survey (2015)

T1 and T2 had similar characteristics; according to the access to production factor, with very limited access to land and less than 3.5 LU. T3 and T4 had more access to land and capital. T1 and T3 had similar characteristics in term of dairy contribution to total income which was more than 85% of dairy contribution. In other words, they were specialized in dairy business. The differences between those types were access to land and production factors (workers and herd size). T1 had characteristically lower access to land and capital than T3. On the other hand, the contribution of dairy income of T2 and T4 was less than 60 percent to total income. Crops (T4) or off farm activities (T2) played an important role to generate income. On average, T2 had smaller size of herd and limited access to land meanwhile T4 had better production factors.

Economic and technical performances according to the farm types

The total net income per farm was the highest for T3 and T4 farm types, which had larger access to land and livestock (Table 20). Considering the productivity of the production factor, the labour productivity was the highest in those two types. The average annual net total income is above 24 million IDR, which is just above the threshold of the average salary. For T1 and T2, with less access to land, the average labour productivity is under the threshold. The land

productivity, considering the net agricultural income per hectare, was the highest in those two types. Farmers with limited access to land remain able to produce milk and generate income by using for instance natural grass in surrounding area and paddy straw. The land productivity is lower for T3 and T4.

Table 20 Economic performances and productivity of the production factor (labour, land and herd) of the four farm types

Farm types	T1 (n=138)	T2 (n=62)	T3 (n=94)	T4 (n=61)
Total net annual income per farm (million IDR)	28 ± 20.8 ^C	32.6 ± 20.8 ^{BC}	51.2 ± 52.9 ^A	44.6 ± 48.2 ^{AB}
Total net annual income per family worker (million IDR)	16.6 ± 13.7 ^B	20.7 ± 15.6 ^{AB}	28.2 ± 34.9 ^A	24.9 ± 27.8 ^A
Net annual agriculture income per hectare (million IDR)	532.2 ± 790 ^A	576 ± 1416.7 ^A	136.5 ± 326.6 ^B	379 ± 965.7 ^{AB}
Net annual dairy income per LU (million IDR) ¹	9.1 ± 5.8 ^B	13.1 ± 18.2 ^A	9.9 ± 6.9 ^B	5.9 ± 5.6 ^C

Means in the same line with a different superscript differ significantly ($P < 0.05$); NS not significant (Fisher, LSD)

¹ = milk income coop + additional product (cows, calves, manure sales) – cattle purchase – additional feed cost (tofu and cassava waste).

Source: survey (2015)

Considering the herd productivity (net dairy income per LU, Table 21), two features were noticeable. The herd productivity was very low in T4, crop-dairy mixed farm, and was the highest but very variable in T2, very small specialized dairy farm with off farm activities (Table 21). Indeed, the milk yield was highest in T2, but with a huge variability: the standard deviation was three times higher in T2 (12.3 litres) than in the other three types (2.9 to 3.3 liters). The milk income from the cooperative presented the same tendencies. In types T2 and T4, the composition of the concentrate diet was different. T2 used many feed concentrate from the cooperative, but also from additional sources (tofu and cassava waste). This could explain the better average milk yield, but also the high variability of the milk yield in T2. In contrast, the T4 farms also used many cassava and tofu waste, but much less concentrate from the

cooperative. Farms T4, at the year of the survey, generated only 2.6 million per LU of additional income from selling products from the herd, half of the value of T2 farms. This also explained the difference of herd productivity between T2 and T4. Feeding practices (concentrates) and performances were very similar for types T1 and T3, both specialized dairy farms, with more or less capital endowment. Thus, the level of net income net dairy income per LU was the same and intermediate between the levels of income for T4 (the minimum) and for T2 (the maximum).

Table 21 Technical and economic results of the dairy activity according to the four farm types.

Variables	T1 (n=138)	T2 (n=62)	T3 (n=94)	T4 (n=61)
Daily milk yield per LU (liters)	8.4 ± 3.3 ^B	11.5 ± 12.3 ^A	8.8 ± 3.2 ^B	7.4 ± 2.9 ^B
Annual milk income from coop per LU (million IDR)	9.1 ± 4.5 ^B	13.4 ± 17.1 ^A	9.9 ± 4.7 ^B	8.8 ± 4.3 ^B
Annual feed concentrate cost per LU (million IDR)	4.32 ± 2.21 ^B	5.07 ± 3.52 ^A	4.27 ± 2.01 ^B	3.12 ± 1.86 ^C
Annual additional dairy income per LU (million IDR) ¹	3.41 ± 4.06 ^B	5.62 ± 7.24 ^A	3.78 ± 4.95 ^B	2.57 ± 3.56 ^B
Annual additional feed ² cost and purchase cattle per LU (million IDR)	3.48 ± 3.90 ^B	5.88 ± 8.73 ^A	3.73 ± 3.59 ^B	5.49 ± 4.53 ^A

Means in the same line with a different superscript differ significantly ($P < 0.05$); NS not significant

¹ = cows, calves, and manure sales; ² = tofu and cassava waste

Source: survey (2015)

Farm trajectories

In the sample of 20 farms, the dairy activity started from 1979 to 2013 (Table 22). A majority of the farmers entered in the activity only with calves or heifers (n=12) or with 1 or 2 cows (n=7). Only one farmer started with 5 cows. Actually, this farmer has helped his father's dairy business for seven years. Started with "shared animal", he received fifty percent of milk sold and calves born. After he got married in 2000, this farmer already had five cows and started his owned dairy business even though remaining at the same barn with his father's dairy farm.

As consequence, the maximum capacity at the barn is only for five cows. Due to limited space in the barn, this farmer usually sell the calves born. It is explaining why there is no growth concerning the herd size. Some of the farmers (n=9) succeeded to capitalize, with a high annual growth rate, more than 10 percent, through natural growth and/or purchase of animals, and reached in 2017 a herd size above 3 LU. Some of them began the activity recently (5 years) but others are in the dairy activity for a long time (30 years). At the opposite, 6 farmers, with an annual growth rate less than 10 percent, did not increase the herd above 3 LU, with no more than 2 cows in the herd, after at least 10 years in the activity (n=6). In an intermediate group (n=4), starting only with one or two heifers, farmers managed to reached 3 LU with 2 or 3 cows, in 2017, after 5 or 10 years in the activity.

Table 22 Development of herd size since beginning of dairy farming activity until 2017

Farmers ID	Beginning dairy business (year)	Beginning year		2017		LU ¹	Annual herd growth
		Cows	Heifers	Cows	Heifers		
<i>Low increase and do not reach more than 3 LU</i>							
RF074	2006	0	1	1	0	1	0,05
RF063	2007	1	0	2	0	2	0,10
TP045	2004	2	0	2	1	2,5	0,04
RF004	2000	2	0	2	1	2,5	0,03
PS010	1995	1	1	2	1	2,5	0,05
GD003	2007	0	3	2	1	2,5	0,10
<i>High increase but do not reach more than 3 LU</i>							
PS015	2001	0	1	2	2	3	0,16
GD078	2003	0	1	3	0	3	0,18
RF015	2005	0	1	3	0	3	0,21
IN047	2013	0	2	2	2	3	0,50
<i>High increase and reach more than 3 LU</i>							
RF050	1993	0	1	3	1	3,5	0,13
RF055	2008	1	0	3	1	3,5	0,28
RF018	2012	0	1	2	3	3,5	0,60
RF073	2012	1	1	3	2	4	0,50
IN040	1992	0	2	2	6	5	0,16
RF005	2007	0	3	4	4	6	0,45
RF054	1979	0	2	5	2	6	0,13
PS057	2007	0	3	5	2	6	0,45
RF011	2000	1	2	14	10	19	1,00
<i>More than 3 LU from the beginning with no increase</i>							
IN038	2000	5	0	5	0	5	0,00

¹ LU: Livestock Unit (1 cow = 1 LU; 1 heifer = 0.5 LU).

Figure 32 Six farm trajectories based on activities, land access and herd growth

Farmers ID	Farm traject.	Current farm type	Off farm activities	Herd growth	Land access	Crops
RF015	1-2	2	Dark grey	Dark grey	White	White
RF063		2	White	Soft grey	White	White
IN040	2	2	Black	Soft grey	White	White
TP045		2	White	Soft grey	White	White
IN047	2-1	1	Soft grey	Dark grey	White	White
RF055	1	1	White	Black	White	White
RF004		1	White	Soft grey	White	White
IN038		1	White	Black	Soft grey	Soft grey
RF018		1	White	Black	Soft grey	Soft grey
RF073	3	3	White	Black	Dark grey	White
RF050		3	White	Black	Black	White
PS057		3	White	Black	Black	White
RF054		3	White	Black	Black	White
RF005		3	White	Black	Black	White
RF011		3	White	Black	Black	White
PS015	4	4	White	Dark grey	Dark grey	Black
GD078		4	White	Dark grey	Dark grey	Black
PS010		4	White	Soft grey	Black	Black
GD003		4	White	Soft grey	Dark grey	Black
RF074		4	White	Soft grey	Dark grey	Black

Off-farm activities. White: no; Soft grey: abandoning; Dark grey: starting; Black: keeping

Herd growth. Soft grey: low increase and do not reach more than 3 LU; Dark grey: high increase but do not reach more than 3 LU; Black: high increase and reach more than 3 LU

Land access. White: low land access without increase; Soft grey: low land access with increase; Dark grey: high land access without increase; Black : high land access with increase

Crops. White: low contribution to income / Dark : high contribution to income

We identified 6 farm trajectories (Figure 32). First, farmers moved from farm type T1 to T2 by adding off farm activities (trajectory 1-2, n=2). Second, farmers remained in T2, combining dairy and off farm activities (trajectory 2, n=2). Third, farmers changed from T2 to T1 by abandoning off farm activities (trajectory 2-1, n=1). Fourth, farmers remained in very small specialized dairy farm (trajectory 1, n=4). Even if they succeeded to increase the herd above 3 LU, they only accessed very few lands, and did not manage to increase their land access. Fifth, farmers remained in T3, with specialized dairy farming (trajectory 3, n=6). They all succeeded to increase both herd size and land access. Last but not least, farmers remains in mixed crop-

dairy farm (trajectory 4, n=5). They succeeded to enlarge their land access, but did not increase so much the herd size.

These 6 trajectories could be aggregated in three main groups. In the first group, farmers with very low access to land (types T1 and T2), could remain in their type or moved from T1 to T2 and *vice-versa*, according the practise of off farms activities. Even if they were for a long time in the dairy farming, they did not manage to increase their land access, and kept small herd size. The reasons why farmers moved from T1 to T2, adding some off farm activities, were limited land access for crop activities, limited capital, high availability of family worker and job opportunity. Meanwhile, farmers abandon off farm activity (move from T2 to T1) was mainly due to limited family workers and uncertain income from off farm activity.

From those types (T1 and T2), majority of farmers had difficulty increasing the herd size. For the case remaining in dairy farm–off farm activity (T2), one farmer generated more income from off farm activity (trading of tofu waste) than from dairy business. The dairy business is managed by his child and the income is shared proportionally. Conversely, another farmer generated more income from dairy business than off farm activity (wage worker). If farmers needed money for education, wedding party, health service or uncovered daily expenses, they sold cows. As a consequence, the herd size remained stable and the herd was rather perceived as savings.

In trajectory remaining in T1, farmers tried to enlarge the herd size. They added more cow through credit scheme from cooperative and kept the calves born to be replacement stock. However, they had difficulty to add more cows because of the limited capacity of barn and the need of money to cover daily expenses. Farmers could access credit (to buy cow or to cover daily expenses) from milk cooperative (KPSBU) but the amount is based on their capacity such as financial capital and physical capital. It is explaining why farmers in T1 and T2 have less access to credit than other types. As a consequence, they sold all the calves or some calves to get cash. As we saw above (Table 22), in those types T1 and T2, the average annual income was less than the salary of an unskilled worker. Dairy activities did not fully support the livelihoods of the family.

Farmers in T3 (dairy specialization in small farm) had high and rapid increase of the herd size (Figure 32). Discussion with farmers revealed that the income from dairy business is enough

to cover daily expenses. They also had better capital than other types. In these conditions, they were able to keep some calves to be replacement stock. It resulted stable natural growth because they had more heifer than culled cows. It allowed them to enlarge the herd size. In addition, farmers had another opportunity from dairy development project to receive cows through credit scheme or grant. For instance, in 2012 the dairy development project selected some farmers to be demo farmers and to receive grants (cows, trainings, renovated barn). The project considered some criteria such as human capital (age, education, trainings, experience), physical capital (land ownership, herd size, biogas installation), access to credit, family member and activity generating income (dairy specialization is favorable). It could accelerate on enlarging the herd size. As a consequence, they need more forage to feed the cows. All farmers added more land to produce forage. Some of them optimized workers to cut and carry grass, not only from family workers but also from hired workers.

We identified that majority of farmers in mixed crop-dairy system (T4) did not abandon crops neither increased their herd size. Some of them increased land access but it was more for developing cropping activity, not dairy business. They had some reasons why they did not increase (or only had a small increase) the dairy herd. Majority of farmers T4 mentioned that the optimum number of cows was four cows. If more than that, they had difficulty to manage mixed-farming system. It was because of the low availability of workers, land access, and barn capacity. Other reason was the risk of dairy business such as problem of animal health. This problem affected the income of farmers to enlarge the herd size.

“Until now I can manage time to do both activities (dairy and crop farm). In the morning, after to cut and to carry grass, I go to the crop field. In one condition, the maximum is only four cows. If it is more, both activities (dairy and crop farm) will be unwell managed due to limitation of time, barn and worker”. – GD078

DISCUSSION

Critical analysis of methods

Each data set presents some limitations. The survey of a large sample only enabled a one year assessment of the economic performances. In other words, the result depend on the circumstances of the year. For instance, we found some farmers with negative results in term of Net Dairy Income because of the purchase of cows in that year. Meanwhile, some farmers have high income that might be linked to the exceptional sale of animals that year.

The trajectory analysis was carried out from a small sample of 20 farmers. Nevertheless, the sampling was structured by the farm typology performed from the previous large sample. It enabled having the various kinds of potential trajectories to be present in our sample. Even if the data collection on long term was rather qualitative, we had a better appraisal of the dynamics than from the one-year survey. The limitation is that we only worked with families that have kept milk production at the time of interview. For example, it may be said that mixed farming (T4) is unlikely to have been abandoned in order to specialize in dairy: in fact, we observe no specialized dairy farm nowadays who abandoned the crops in the past (transition T4 to T3), and no mixed ones (today) who are in strong dynamics of the herd and fodder surfaces (toward maybe abandon of crops). On the other hand, maybe mixed farms 10 years ago, have now abandoned milk production and are crop specialized (but those farms cannot be in the sample).

Performances and economic results of the dairy activity

What is surprising is that we identified low dairy performance in farms T4. A possible explanation for this might be that those farms use low nutritive value of feed. They provided small amount of concentrate that can be identified from feed cost. However, they preferred tofu waste with low energetic value (Anggraeni et al., 2013; Rohmiyatul Islamiyati and A.R, Hidayat, 2010) and cassava waste with low nitrogen value (Antari and Umiyasih, 2009) (table 6). It can be seen from the high additional expenses of those feeds used by farms T4.

It is also somewhat surprising that so much variability of dairy performance in farms T2. It may be the case therefore that these variations related to the nutrition of feed and the purchase-sale of animals in that year. Another possible explanation for this is that low access to fodder, due to low access to land, in an area with a very high density of population. Those farmers replaced high quality fodder such as napier grass (Gwayumba et al., 2002; Islam et al., 2003) to low nutritive fodder such as paddy straw (Prihartini et al., 2011) (Table 23). In addition, they provided high quantity of concentrates in the feeding of the cow that might lead to digestive problems and low performance (Dong et al., 2013; Gressley, 2014; Jia et al., 2014; Owens et al., 1998).

Table 23 Nutritive value of feeds

Ingredients	Dry Matter (%)	Organic matter (% DM)	crude protein (% DM)	crude fibre (% DM)
cassava waste ¹	90.5	-	2.8	8.7
tofu waste ²	18.06	97.28	21.10	25.43
paddy straw ³	73.38	74.88	3.47	40.02
napier grass ⁴	20	91	9	31

source: ¹Antari and Umiyasih (2009); ²Rohmiyatul Islamiyati and A.R, Hidayat, (2010); ³Prihartini et al., (2011); ⁴Gwayumba et al., (2002) and Islam et al., (2003)

Number of cows to reach income threshold

One interesting finding is that the number of cows plays an essential role to reach income threshold. The results of this study indicate that the larger size of herd enable farmers reaching income treshold. Around 70 percent of farmers who have more than five cows reach income treshold (regional minimum wage). This also accords with some farmers' justification, which mentioned that having at least five cows is enough to cover daily expenses. Nevertheless, this result has not previously been described. We found no clear evidence that shows how many cows to reach income treshold in Java Island. However, this result further supports the idea of that mentioning farmers who have more than five cows is more efficient (Astuti et al., 2010; Nurtini and Muzayyanah, 2014; Priyanti et al., 2009; Rahayu, 2017).

The future of the development of milk production according to the farm types

The current study found that the main development pathways of the four types of farm are the increase of herd size, land access and the diversification of income generator. Those changes are the response of capital endowment. It then affect the dairy production at farmer's level to ensure income and to provide national market.

The milk cooperative (KPSBU) play an essential role in the dairy production in the area. They enable farmers having better access in milk market. According to the cooperative officers, the strong relationship between farmers and cooperative allows farmers to keep dairy business. It underlines the importance of market access in dairy business as mentioned by Moll et al., (2007). However, poor farmers (T1) have constraints in increasing the herd size due to limited

working capital. Meanwhile, higher capital farmers (T3) are able to develop the number of dairy cows and land access.

Farms with very small access to land

Our results indicate that dairy farming even though with very small access to land, offers some interest that attract people in the area to manage this activity. Dairy activity provides not only income but also savings (animals) to sale to cope with big expenses in the family, health issues or wedding party for instance. In addition, the dairy activity offers job opportunity especially for family members. Nevertheless, this activity do not always provide enough income, because of the difficulty to capitalize in order to have regularly 2 or more cows in production. Even so, the dairy activity supports a part of the family livelihoods.

Those very small farms play a key role to national market. They supply dairy industries and national milk market. They are numerous and they weigh in the supply of the coop: T1 and T2 count for 56 percent of the farms – from the 355 farms sample, and they provide 47 percent of the milk delivered to the cooperative. Small producers with two cows, supplying milk industry is a frequent situation in other developing countries (Le Gal et al., 2007; Sraïri et al., 2009) and in South East Asia particularly (Devendra, 2001; Moran, 2009).

The smallholders are in critical situation. Those farms with few assets will be more vulnerable to continue dairy business. Dairy activity does not always cover daily expenses due to herd size and low economic performance. It is due to the constraints to improve other production factors in particularly land access and herd size. To response the scarcity of land access, some farmers nowadays use forage outside the farm through purchase or cut and carry natural grass. However, it remains uncertain for the continuity in the future considering the availability of forage and the land conversion in the surrounding area. To enlarge the herd, farmers could access credit from cooperative but the amount is based on their capital. In other words, they could only access limited cash.

Off farm activities in the very small farms

The off farm activities, providing incomes from family workers not occupied by dairy farming, is a pathways to maintain dairy production. Surely, they are very various situations in T2. In some cases, off farm activities are the main source of income. Dairy provides savings through animals and farmers do not invest too much in dairy. In other cases, the off farm activities, if

people could access salary work for instance, are a necessity in order to complete the small income from dairy herd. The balance between dairy and off farm activities could also explain the high variability of technical results in T2 farm type.

Poor farmers in T2 farm type are more changeable in their trajectories. Barrett et al., (2001) identified some motives why farmers add or abandon off farm activities such as coping with shocks, risk reduction, economies of scope, missing or incomplete markets, diminishing returns to productive assets and seasonal and interpersonal aggregation. In our case study, the relevant motives are the missing or incomplete markets (land, labor and financial market) and the risk reduction. It does not confirm a study conducted by McNally (2001) that mentioning small farms are difficult to pursue diversification.

Diversifying with off farm activity become a natural response if a family farm has a high labor but limited access on land. Due to incomplete land and labor market, family workers would be allocated to another activity to optimize production factor. On missing or incomplete financial market (credit market and insurance), off farm activity play an important role to cover the constraints to purchase production factor (Barrett et al., 2001). Although, milk cooperative can provide credit and insurance, but farmers had limited capital to access this credit. Discussion with farmers revealed that they have difficulty to cover daily expenses if only depend on dairy business. Small (less than three cows) and slowly increased of the herd size, are resulting limited income (less than regional minimum wage) from milk selling. The two things explaining why herd size remains small: calves are usually sold to cover cost and daily expenses; and limited capital does not allow buying a new cow. In the limitation of the working capital and the presence of incomplete financial markets, off farm activity become an essential response to continue their dairy business.

Risk reduction is another motive why dairy farmers diversify their activity (Barrett et al., 2001; Hansson et al., 2013). Diversification is more like self-insurance to reduce the income variability (Barrett et al., 2001). Our study indicated that the poor farmers (particularly in T2) have off farm activity as a way to minimize risk from dairy business. It confirmed the studies conducted by García-Arias et al., (2015); Madelrieux et al., (2015) indicating that diversification can reduce risk associated to the dairy business. Input price (feed, equipment, land) and output price (particularly milk price) remain uncertain. At the time of survey, for instance price of concentrate was IDR 2500 per kg meanwhile price of milk sold to cooperative

was less than IDR 5000 per liter. In other words, if one kg of concentrate can produce one liter of milk, the revenue can only cover concentrate feed. Adding off farm activity became a solution as risk reduction.

On the other hand, reducing off farm activity was mostly because of less availability of family worker. It might be related to incomplete labor market (Barrett et al., 2001). Decreased family worker (passed away, married, etc.) while increased quantity of cow, make farmers abandon off farm activity and focus on dairy business only. Dairy business with more than four cows is enough to cover daily expenses. In addition, it enable farmers to add more cows through credit scheme or cash due to sufficient capital (mainly physical and financial capital). It is in line with Baccar et al., (2016) that underscoring the importance of labour force and capital on farm development pathway.

Strategy to add off farm activity is a good decision to secure family income and to overcome constraints in production factors. Furthermore, increasing herd size through credit scheme might not be enough to support those type of farms. It could be effective if followed by increasing other production factors (land access, forage, concentrate, etc.) as well. This study supports evidence from previous observations conducted by Sembada et al., (2016). Feed subsidy by government and cooperative also play a key role to reduce feed cost to generate more income.

Farms with higher land access and mixed crop-dairy system

Interest of the mixed system could be seen not only from technical point of view such as use of crop residues, use of manure, but also to secure the system from an economic point of view, combining two activities as income generator. We identified no dynamics of development of dairy production in those mixed farms. Even though, family may have abandon dairy production and specialize in crop productions (but not observed due to our sample, with only dairy farms).

Those mixed crop-dairy system (T4) may continue their dairy business. In term of development of dairy production to ensure income and to provide national market, those farms tends to be stable or slightly increased. They are not so numerous (17 percent of the farms) and contribute only to 15 percent of the milk delivery to the coop. In other words, farm size (herd, land access for forage, workers) is slowly developed. It might related to their working capital (in

particularly family labor and land) that should be managed optimally for two activities in order to have better family income. In addition, labour productivity in crop could be higher than in dairy production. So there is no incentive for the family to develop more dairy than crop, enlarging the land dedicated to forage, at the expense of crops (and to specialize in dairy production).

External factor particularly land access to Perhutani or PTPN can affect their dairy production. Majority of them depend on this land to cultivate grass. Their land (owned and rented) are mainly used for crop. For forage production, they cultivate mainly on Perhutani or PTPN land. In Indonesia, it is kind of land use arrangement by community surrounding area and Perhutani to manage forest together (*Pengelolaan Hutan bersama Masyarakat-PHBM*). People cultivate grass or crop on forestry land as long as forest remain well managed. In a given context, farmers may also cultivate grass on unused land of PTPN as long as it does not affect productive land. However, these arrangements might be vulnerable due to the uncertainty of the land conversion in the future. It underlines the importance of self-sufficiency in production factors including land (Lebacqz et al., 2015; López-Ridaura et al., 2002; Ripoll-Bosch et al., 2012).

Farms with higher land access and dairy specialization

Bigger farm with dairy specialization (T3) have two major motives why they choose specialization in dairy than mixed farm. First, they have less availability of family worker. Discussion with farmer revealed that unavailable family worker cause farmer choose only one activity. Second motive was limited land for crop in surrounding area. Farmer mentioned that it will need larger size of land. They prefer to use land to cultivate forage since they have larger size of herd. Deciding to have only one activity is the best way to manage the resource optimally.

Those farms (T3) are in a development pathway. They succeeded capitalizing (herd and land access). They have enough cows to ensure an income above the threshold, but there is still a high variability of the income per worker. Even though, the number of cows is not enough to guarantee income, but it plays an important role to generate more income or to be an asset.

They have better capital than other types of farm. Higher capital (including herd and land) enables farmers accessing more credit from cooperative and dairy development project to overcoming other constraints of production factor. In this condition, farmers have complete

market. Theoretically, Barrett et al., (2001) explained that in the presence of the complete financial market, farmers only use some part of the income portion and saving the rest. It then allows farmers to have stable natural growth of their animal.

T3 farms count for 26 percent of the farms, but they provide 38 percent of the milk delivery. In average, T1, T2 and T4 farms supply 10 000 liters of milk a year to the coop. A T3 farm delivers 17 000 liters. Those farms might play a key role to the dairy production in the region as well as national level. Nevertheless, in a dairy development policy to supply national market, to focus only on T3 farms is not relevant. It is because the difference of size between producers is not too much.

Synthesis of the chapter

To understand the dynamic at farmers' level, we conducted a farm trajectory analysis. First, we built a farm typology based on the data obtained in the survey presented in the previous chapters. Second, we compared the performances of each type of farm. Third, for each type of farms, we conducted a trajectory analysis. This analysis was done in a limited number of farms (20 in total).

The chapter clearly underlined the following findings. Each type of farm show different strategies to ensure sustainable family income. Those strategies have various impacts on the provision of milk to the national market, and on the development of the national dairy production. Farms with limited capital endowment are not able to increase their herd, and to improve their contribution to the development of the national milk supply. To face their limitation in terms of agricultural assets, some farms conduct off farm activities. The main reasons that explained their difficulty to increase milk production are related to their constraints to access means of production (land, labour and financial resources) and the risks that they are facing. Mixed crop-livestock systems remain stable in terms of milk production because they manage optimally the resources for two activities. Of course, the contribution of this type to national production might be increased if some cropping farmers decide to buy 1 or 2 milking cows to start a dairy business. Specialized farms with high capital endowment increased their herd size rapidly. This type contributed at a higher level to the rise of national production. In the future, this type might play an important role in the development of dairy production in Indonesia. Nevertheless, to focus only on this type of farm will be irrelevant due to the different size of farm is not so much. In addition, other types are also important due to their high number.

This chapters clearly shows the important of capital endowment and diversification strategies on the sustainability of dairy farming system in Indonesia. It provides a dynamic approach which is important to understand the strategies of the farms to ensure family income. The following section discusses those main findings and relevant policy strategies.

DISCUSSION

The objective of this chapter is to discuss our results on the sustainability of smallholder farms, and to answer our main research question: “in what conditions smallholder farms will be sustainable in the future?”.

Before starting this discussion, it is important to expose some elements related to the methods that we used. As mentioned in the literature review, numerous studies have been conducted to evaluate the sustainability of farming systems and many tools have been developed to assess it (Barbier and Lopez-Ridaura, 2010; Gaspar et al., 2007; Khanh et al., 2017; López-Ridaura et al., 2002; Ripoll-Bosch et al., 2012; Van Cauwenbergh et al., 2007; Zahm et al., 2007). In our study, we used the framework proposed by López-Ridaura et al., (2002) to identify the sustainability indicators that are relevant in our local context. This participatory approach allowed us to identify the critical points and to select sustainability indicators. The idea was to produce a limited number of indicators that could represent each sustainability pillars (economic, social, and environmental). Furthermore, we carried out the sustainability assessment of 355 farmers, using those indicators and other variables to explain why some farms showed better performances in one dimension than in others and *vice-versa*.

To set a better understanding of the future of smallholder farms, we also conducted diachronic analysis. Prior studies (Khanh, 2017; Cots-Folch et al., 2009; Rueff et al., 2012; Ryschawy et al., 2013, 2011) have noted the relevance of the trajectory analysis for understanding the dynamic at farmers' level. We conducted an analyse of the trajectories of 20 farmers that represented all types of farms. Combining those two methods allowed us to learn about the sustainability of smallholder farms and to understand the dynamics of their sustainable development.

Because of those methodological choices, our study has some limitations. As mentioned in the chapter 3, the main limitation of our method is that we only surveyed families that were involved in milk production at the time of the survey. For example, some mixed farming systems (T4) could have abandoned dairy production in the previous month. But those farms that had abandoned milk production were not included in our sample. Likewise, we did not survey agricultural farms that had a plan to develop a dairy production in the future. Because of that, our survey is likely to have missed some of the dynamics of the mixed farms. However, we still got interesting results on this topic: we observed no specialized dairy farm who abandoned the crops in the past (transition T4 to T3). And we did not observed mixed ones

who were in a strong dynamic of raising the dairy herd and fodder surfaces in an attempt to abandon crops.

Having made those preliminary comments, we will now develop our general discussion.

1. Sustainability of smallholder farms

1.1 Smallholder and its constraints to be sustainable

In the introduction, we described general picture of the smallholder farming system and its constraints. The definition of the smallholder is varied among countries. However, generally they have similar characteristics such as small size of farm, run mainly by family workers, traditional system, as well as the product is partly for family consumption (Altieri et al., 2008). In Indonesia, Ministry of Agriculture in 2002 defined smallholder dairy farm as a side business which characterized by small scale (with maximum 20 dairy cows).

The study confirms that farmers had to face some critical points to be sustainable. We discussed those critical points with farmers before we built the sustainability indicators. Discussion with farmers revealed their different limitations according to their type of farm. The availability of water, limited family worker, high dependency on external resources, waste management, and low price of milk were the main critical points. This situation was also reported by other authors (Atuhaire et al., 2014; Devendra, 2001; Kuivanen et al., 2016; Nkya et al., 2007). Those constraints were mainly pointed out by farmers who had a mixed crop-dairy farm with small and medium capital. Farmers who had pluriactivity with small capital underlined other limitations such as the profitability of dairy farm, limited access to land, and low availability of forage. Such findings were also reported by Devendra, (2001); and Tebug et al., (2012). Specialized farms with limited capital mentioned that low access to land and forage, low profitability, and high dependency on dairy business were the main challenges. This is coherent with earlier studies conducted by Devendra (2001); Poulton et al., (2010).

1.2 Indicators of sustainability

The fact that farmers in every countries have different challenges to be sustainable (Atuhaire et al., 2014; Devendra, 2001; Tebug et al., 2012), a sustainability assessment with appropriate method is needed. In the present study, a MESMIS framework proposed by López-Ridaura et al., (2002) was adapted to build the indicators of sustainability. Related studies have been done with this approach particularly from developing country. This approach allows to build the indicators considering the participatory approach and the data availability.

First, the critical points were identified by preliminary study, literature study and in-depth interview with farmers and stakeholders. Considering all perspective, we set some critical points in the local context. Based on those points, criteria and strategic indicators have been developed. Second step, another in-depth interview with experts were conducted to validate and to understand the main strategic indicators. The experts judged the level of importance for each indicators.

We selected the main importance indicators represent three pillars of sustainability to evaluate the sustainability. The total income per family worker represented economic pillar. The willingness to continue dairy business was selected to represent social pillar. Waste management practice represented environmental pillar. In addition, three other indicators were listed to response vulnerability of family. Herd size per worker, owned land per worker, and diversity were chosen as strategic indicators to evaluate the sustainability of dairy farming system.

1.3 The link between type of farm and pattern of sustainability

Since we have patterns of sustainability (in chapter 2) and types of farm (in chapter 3), a link between has to be described. The results varied among them (Table 24). However, the majority of farms in each type and pattern of sustainability could draw the general picture of the link. We also performed correspondence analysis (cf annex 5) to confirm the link between type of farm and pattern of sustainability.

Table 24 link between type of farm and pattern of sustainability

Type of farm	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
1 (n = 138)	11 (14%) 8%	50 (56%) 36%	40 (48%) 29%	30 (50%) 22%	7 (15%) 5%
2 (n = 62)	33 (43%) 53%	9 (10%) 14,5%	10 (12%) 16%	1 (2%) 2%	9 (20%) 14,5%
3 (n = 94)	10 (13%) 11%	25 (28%) 27%	23 (27%) 24%	24 (40%) 26%	12 (27%) 12%
4 (n = 61)	23 (30%) 38%	5 (6%) 8%	11 (13%) 18%	5 (8%) 8%	17 (38%) 28%

Type 1 (T1) has the biggest percentage for the three patterns of sustainability (P2, P3, and P4). Majority of type 1 (T1) (36%) is in the pattern 2 (P2). The characteristic of T1 is the specialized farm with the low capital and low access to land. The characteristic of P2 and P3 are low level of sustainability for almost all indicators. The difference among them is only the higher social sustainability for P2 than other patterns. The result shows that specialized dairy farms with the low capital and low access to land have low score of sustainability for almost in all indicators. However, the majority of farms will continue their dairy business. Farmers think that dairy business is still a profitable business under some condition. Mr Jajang mentioned:

“I never think to convert my activity. Income from dairy business can cover daily expenses. Dairy business can be an ideal business if at least farmers have six lactating cows. The problem is that limited land access to cultivate forage”.

Type 2 (T2) was a dominant type in the pattern 1 (P1) of sustainability which represents 43 percent of the total farms in this pattern. This type characteristic has low capital with pluriactivity to generate income. P1 is characterized by low level of sustainability but less vulnerable than P2 and P3. In other words, farms with pluriactivity low capital has higher sustainability than farms with low capital but only one activity generating income. Discussion with farmers revealed that off farm activity such as wage worker and trader is important to generate additional income. Farmers in this circumstance have limited income from dairy business. Depending only on dairy business is not enough to cover farmers daily expenses. In addition, farmers have limitation such as lack of ability, experience, and capital to have another activity such as crop farm. For this type, pluriactivity is a solution as a response to their limitation. In accordance with the present results, previous study conducted by Barrett et al., (2001) have demonstrated that farmers have some motives to add or to abandon off farm activity such as coping with shocks, risk reduction, economies of scope, missing or incomplete markets, diminishing returns to productive assets and seasonal and interpersonal aggregation.

Farms type 3 (T3) distribute to three patterns of sustainability (P2, P3, and P4). Major characteristic of this type is in P2 and P4. T3 by small specialized dairy farm. Farmers accessed more or less 0.77 hectare of land per farm. This type had the highest economic performance than others. P4 is characterized by high level of sustainability but more vulnerable than P5 in particular to face fluctuative of milk and input price. Farmers T3 in P4 is explained by their capital and high access on the land to promote their level of sustainability. Otherwise, farmers T3 with low sustainability (P2 and P3) might be related to their land ownership.

Even though, farms T3 have more access to their owned land, rented land and PTPN/Perhutani land than the other types. Discussion with farmers showed that land ownership is important to enhance level of environmental sustainability. Farmers could install biodigester in their owned land to improve the waste management practices. In addition, owned land could reduce the cost of dairy business. It resulted better economic performance and it can boost economic sustainability. Socially, it also important as guarantee for the farmers to continue dairy farming activity. The land from rented land and PTPN/Perhutani is uncertain. We can conclude that farmers in this type will have two possibilities of sustainability level: high sustainability (P4) or low sustainability (P2 and P3). It depends on the degree of autonomy in particular their land ownership.

For forage production, it still depend on the land rented from PERHUTANI (state forestry company). He pointed out that if the farmers had no longer rent this land, it would be very difficult to provide forage to the cattle. This result reflect those of Lebacq et al., (2015); López-Ridaura et al., (2002); Ripoll-Bosch et al., (2012) who underline the importance of self-sufficiency in production factors including land.

In pattern 5 (P5), type 4 (T4) has the biggest percentage than other types. This type represents 38 percents of P5. The characteristic of T4 is mixed farm (crop-dairy business) with medium to high capital. P5 is characterized by the most sustainable dairy farm with balance and higher level of sustainability than other patterns. In other words, crop-dairy farms with medium to high capital can have better sustainability than other types. This dairy farming system has less risk than specialized farm in particular to face fluctuative price of milk and input. It underlines that mixed crop-dairy business with medium to high capital become a better model to enhance the sustainability of dairy farming system. This mixed farming system broadly supports the work of other studies conducted by Barbieri and Mahoney, (2009); Ryschawy et al.,(2013).

1.4 The changes and its drivers

Milk production system has changed since the introduction of dairy farm in Indonesia at the beginning of 1900's. Three main changes exist. First was the change from large farms (milk enterprise) to smallholder one. Second was adding or abandoning off farm activity as a response to overcoming the limitations of production factors. Third change was the high increase of herd size for those who had specialized and better working capital. Each change

had different drivers. Those changes then affected the dairy production at farmer's level to ensure income and to provide national market.

The change from the milk enterprise to smallholder farm has mainly occurred in 1942-1950. We identified the drivers which mainly from external. In that period, Japan came to Indonesia and took over the colonialisation of Indonesia from Dutch (1942-1945). After the independence in 1945, Indonesia had physical revolution to defend their independency from Netherland. It resulted emergency situation for milk enterprises which runned mainly by Dutch people. In addition, the price of feed was highly increased. It caused the milk production sharply dropped. As the consequence, the owner of milk enterprises abandoned their dairy business. Many dairy cows were slaughtered and some of them were distributed to the local smallholder farmers. It was a turning point from milk enterprises to smallholder farm (Subandriyo and Adiarto, 2009).

Our results show that the change has occurred from poor farmers to add off farm activity as a response to overcome their limitation. This finding is also reported by Barbieri and Mahoney, (2009); Barrett et al., (2001); Hansson et al., (2013). Farmers added off farm activity as a complementary of dairy farming income. Discussion with farmers revealed that the drivers of change derived from internal and external factors. Internal drivers were limited capital, limited farm income, off farm income, limited access to land, and risk from dairy business.

Farmers in this type had limited capital. The capital was not only physical capital such as cows, barn, and owned land, but also human capital (know-how). It resulted the limited income from dairy business. Farmers were hard to cover their daily expenses if only depend on this activity. In addition, land access to cultivate forage was limited. Some farmers lived in the center of district where the land are mostly for housing. Some others who located near forest or tea plantation could access forestry land or unused land at tea plantation to cultivate forage. However, it was uncertain because in the future Perhutani or PTPN will probably use those land for their business. By doing pluriactivity, farmers can reduce the risk from dairy business such as uncertain price of milk and input, and limited access to production factors. Even, some farmers mentioned that off farm activity such as trading and wage workers generated more income than dairy business. Diversifying with off farm activity become a natural response if a family farm has a high labor but limited access on land. On missing or incomplete financial market (credit market and insurance), off farm activity play an important role to cover the

constraints to purchase production factor as well as to reduce risk from dairy business (Barrett et al., 2001).

The external drivers why farmers added off farm activity were the job opportunity and the land conversion. The study area are located in the tourism area. It offered job opportunity for example trading souvenirs, foods and wage workers. In Subang, due to farm located near tea plantation, it also offer job opportunity to be wage workers. Beside job opportunity, the land conversion from agricultural land and unused land to be housing was also the external driver. It reduced the access land to get the forage. Reduced land access and forage access generated low income from dairy business. As a consequence, farmers added another activity generating income as a complementary income. This study confirms that diversifying activity is important in order to reduce risk from one activity (Hansson et al., 2013).

There is also farmer who abandoned off farm activity. An in-dept interview with farmers indicated that some farmers abandoned off farm activity because of five drivers. The internal drivers of change including limited family worker, improved dairy business, and increased dairy income. Meanwhile, the external drivers were the subsidy or grant from dairy development project and easy access to credit.

Limited family worker plays a key role as a consideration farmers to change the activity. One farmer mentioned that after a family worker had passed away years ago, they abandoned pluriactivity and decided to focus only on dairy business. This farmer was hard to manage two activities at the same time. In other side, the physical capital was increased and the dairy business was improved. Since the number of cow was increased, farmer needed more time to focus on managing the dairy business. It boosted the milk production and the farm income. Abandonment of pluriactivity was a solution to keep their dairy farm well managed. These results are in accord with recent studies indicating that the incomplete market (including land and labour market) cause adding or abandoning off farm activity (Barrett et al., 2001).

The external drivers were subsidy or grant from dairy development project and easy access to credit. Government, milk enterprise, cooperative and stakeholders provided cows for farmers to boost dairy cow population and milk production in Indonesia. For example, in the study site, a dairy development project was exist in 2007 and 2012. The project helped new dairy farmers to purchase three pregnant cows through credit scheme. In 2012, this project also provided

revolving cows to selected farmers. Selected farmer received a cow and after two times calving, this farmer distributed the cow to another farmer. Each selected farmer obtained milk and two calves. This model of grant was exist since a long time in Indonesia. Those factors improved dairy cow in each farm and increased economic performance. Therefore, with a profitable income, it drives farmer to focus only on dairy business and to abandon off farm activity.

Another change is the increase of the herd size as well as land access particularly for those who had capital and specialized farm. Farmers have enough cash to cover daily expenses. In addition, higher capital enable farmers to access credit to overcoming the constraints of production factor. In this condition, farmers have completed the financial market. Theoritically, Barrett et al., (2001) explained that in the presence of the complete financial market, farmers only use some part of the income portion and saving the rest. It then allows farmers to have stable natural growth of their cattle.

2. In what conditions, smallholders farm will be more sustainable?

2.1 Which type of farm will be able to support the development of national production?

In the study site, we identified four types of farm and five patterns of sustainability as well as the link among them. Each type and pattern have different role and characteristic in particular to be sustainable and to support national production. In this part, we discuss about what type of farms that support national production.

The study allows us to understand which type of farms that contribute more to domestic output than other types. Our study indicated that farms type 3 (T3) in the pattern 4 (P4) enable to support the development of national milk production. This result seems to be consistent with other research conducted by Khanh et al., (2017) in Vietnam. Farms T3 were small to medium capital with high access to land compared to other types. The characteristic of P4 was medium to high sustainability but more vulnerable than mixed crop-dairy farm. In other words, farms T3 in the P4 were farms that had better access to land and capital with medium to high sustainability.

Three reasons might explain why those farms enable to give better contribution than others. First, we identified, those farmers had high milk production compared to others. Due to the larger size of herd and more efficient in dairy farming practice than others, those farms enable to produce more milk. In this condition, farmers received better incomes than others. Second, through a trajectory analysis, we identified that those farms had rapid increase of the herd size. The income from dairy business could cover their daily expenses so that farmers could keep some calves as the replacement stock. Third, due to specialized farms, those farmers focused to enlarge their dairy business. The increased number of cows and the availability of family workers supported to enhance production factors such as land ownership and forage access. In the end, it boosted milk production performance. Overall, with some reasons, those farmers contributed to national milk production.

In the future, those farms will contribute national production under three conditions. First, those farmers increase the production factors. The main production factors are for instance access to feed (forage and concentrate), access to land (owned and rented), availability of workers and cows. Second, farmers adopt the technology of dairy farming practices for example machine for milking and for cutting the forage. It allows to boost the efficiency of

workers. Third, government and stakeholders keep the stability of milk price and input price. It makes sure that the dairy business remain profitable. It also boosts the desire of other farmers to continue dairy farming activity.

Even though, those farm might play a key role on national dairy production, to focus only on this type could be not relevant. It is because the different size of farm is not too much and the high number of poor farms (T1 and T2) is important to the national dairy production. Those small farms can contribute to reducing poverty, opening job opportunity, and improving nutrition (Hemme et al., 2010).

2.2 Factors influence their sustainability: role of capital and diversification to be sustainable

The present shows the role of capital and diversification to be sustainable. There are two main factors explaining the different level of sustainability. In this part, we discuss how those factors influenced the level of sustainability.

High capital can enhance the milk production and the efficiency of dairy business. It then resulting high economic performance from this business. This also accords with previous study conducted by Khanh et al., (2017), which showed that specialized farm with higher capital have better economic performance than other types of farm in Hanoi, Vietnam. Increased economic performance can boost the economic pillar of sustainability. Economic pillar of sustainability influence two other pillars (environmental and social pillar). Overall, it will lead to high level of sustainability.

On the other hand, diversified activity plays a key role to make farmers less vulnerable. In Europe, Hansson et al., (2013) explained that diversity can enhance rural economic growth, migration and employment. Diversity is a distinction of different activities outside the conventional agriculture activity, for example processing, marketing and retailing to meet the needs of particular consumers (Hansson et al., 2013). As long as the activities use farm resources and generate income, it is defined as diversification. For example, farmers only have livestock, but it is considered as diversification if the processing or retailing activity use the farm resources and generate income. This concept is almost similar with the study conducted

by (Barnes et al., 2015; McNally, 2001). Another concept of diversity is if farmers have two different activities generating income, for example crop activity and dairy farming activity.

Farmers have different goals and factors explaining why they diversify their activity. Barbieri (2010) identified four goals driving agritourism and on-farm entrepreneurial development (diversification) in Canada by performing importance-performance analysis. The result showed that “to continue farming”, “to enhance family quality of life”, “to increase or to diversify the market” and “to respond to a market opportunity” were the main goals why farmers do diversification.

In our study, diversified activity is divided into two categories including pluriactive farm (dairy farm-off farm activity) and mixed crop-dairy farm. Generally, the aims of diversified activity are to minimize the risk from dairy business and to enhance family income. Suess-Reyes and Fuetsch (2016) explained that farmers diversified their activity as an innovative farm strategy in order to reduce the risk. The risk from dairy business such as the fluctuative price of milk and input and the availability of land access influence dairy income. If farmers only depend on dairy business, they are vulnerable when they face such risks. However, if farmers have another income generator, they remain survive when they face the risk from dairy business.

Barbieri et al., (2008) reported that farmers tend to combine farm activity and off farm activity by spouses to reduce risks. It is also in line with study conducted by Bhende and Venkataram, (1994) that underline the importance of diversification in order to reducing risk and increasing income. Farmers do this strategy in particular if they had difficulty to have diversified activity for example crop-livestock. Furthermore, Barrett et al., (2001) identified some motives such as coping with shocks, risk reduction, economies of scope, missing or incomplete markets, diminishing returns to productive assets and seasonal and interpersonal aggregation. In our case study, the relevant motives are the missing or incomplete markets (land, labor and financial market) and the risk reduction.

2.4 What the future strategies

As described in the introduction, the Indonesian Government designed the “Blue Print of Dairy Sector 2014-2025” (Kemenko Perekonomian, 2013). This policy program proposes an

integrated framework to support the sustainable development of dairy production. However, this program has to be adapted to each type of farm, in particular for the large diversity of smallholder farms. Characterizing the trajectories of different types of farms and as well as their pattern of sustainability could help policy makers to design appropriate and sustainable dairy policies. We believe that by understanding the specificity of each type of farm, policy makers could precise the strategies to specific target to reach the goal effectively.

Specialized farm with low capital and low access to land (T1) is distributed into three patterns of sustainability (P2, P3, and P4). This type of farm represent the largest quantity farms in the area. The majority of this type has the low level of sustainability with the high willingness to continue dairy bussiness (P2). To survive in the future, adding capital is a solution. Providing cows (via credit scheme or revolving cows), promoting technical support (know-how), and providing low cost of production factors are important to be conducted. It can boost the economic performance of dairy business as well as the sustainability. The feedback if they are sustainable is that the job opportunity from this sector will be kept. Due to the high number, small-scale farm could contribute to reducing poverty, and to reducing malnutrition (Hemme et al., 2010).

Majority of pluriactive farms with low capital (T2) have the lower level of sustainability (P1). This type is characterized by the low economic performance from dairy business. Pluriactivity is a way to overcoming the limited income from dairy business and the constraints of production factor (Barrett et al., 2001; Hansson et al., 2013). Therefore, this type has a lower risk than specialized farms to face the uncertainty of milk price and input price. The appropriate strategy for this type is enhancing the capital, land access and know-how. Increased number of cow for a minimum five lactating cows enable them to have better income from dairy business. In addition, increased know-how via training enable them to have more efficient dairy business. It also promotes economic sustainability. Increased economic sustainability could affect other pillars of sustainability. Those strategies not only enabling farm to be more sustainable, but also can contribute to national production. However, it remains a problem if land is not accessible. For the moment, they could purchase forage and cut and carry grass from surrounding area, but in the future it will be uncertain. The forage market through cooperative or other stakeholders might be a solution to face this constraint in the future.

Small specialized farm with medium access to land (T3) is also distributed into three patterns of sustainability (P2, P3, and P4). This type plays an essential role in contribution to national milk production and national market. Characteristically, they enlarge the dairy business through adding more cows. They have high and rapid increase of the herd. The appropriate strategies is to improve the access of production factors in particularly owned land. Owned land enable farms in this type to be more sustainable. This strategy can make farmers move from P2 (low level of sustainability) into P4 (medium to high level of sustainability). However, it is difficult to change farmers into P5 (with diversified activity) because majority of farmers only focus on dairy business since the beginning of dairy business. Even so, promoting diversification might be a mean to promote higher sustainability.

Farms pattern 5 which is majority from mixed crop-dairy with medium to high capital (T4) is considered as the most sustainable farms. The strategy to increase the know-how and to adapt technology to this pattern will help them to face the main limitation of the availability of family workers. This strategy can increase the working productivity. Increased working productivity enable farmers to enlarge their dairy business even when farmers remain manage crop farm. Furthermore, it can boost national milk production.

Another strategy is increasing the shared animal to other farmers mainly from T1 and T2. It allows to have better collaboration among type of farms. Sharing animal exists in Indonesia. The agreement among farmer and the owner is vary. Another farmer manages and raises the dairy cows from owner, then farmer will receive fifty percent of dairy income each month and of calves borned. This strategy can overcome two limitations such as small number of cows (T1 and T2) and limited family workers (T4).

CONCLUSION

The thesis aimed at understanding in what conditions smallholder dairy farms will be sustainable in the future. Smallholder farms are facing many challenges such as shortage of capital, access to good quality natural resources (soil and water), uncertain climatic conditions, and economic hazards. Because of that, dairy farming might be relevant to secure the livelihoods of rural smallholders, but it might also be associated to risks and unsustainable livelihoods. In that context, “in what conditions smallholder dairy farms will be sustainable in the future?”

The first chapter discussed about the situation and the needs of dairy farms in a small region of the West-Java province. It allowed to understanding the role of a dairy development project. In this region, as in the rest of the country, smallholder dairy farms have limited capital. On average, farmers only have three cows per farm with less than 0,3 hectare. The dairy development project that we studied played a key role in increasing farmers’ livelihood. By supporting access to credit and technical support for farmers, the dairy project improved milk production performance. The project focused on increasing capital (cow and barn) and know-how. It was a good start. However, the activities of the project had to stop and they were not sufficient to develop dairy farms at a high level of sustainability. It should have been followed by some activities to secure the main production factors such as land and forage. This chapter was an initial step to answer our research question.

To make a better response to the question, we conducted in chapter two an assessment of the sustainability of smallholder dairy farms. The most sustainable farms were those who had higher capital and diversified activity (farms pattern 5). Farms with low capital who could develop an additional activity (pattern 1) were more sustainable than specialized farms (pattern 2 and 3). The capital endowment and the level of diversification of activities on farm both play important roles in the sustainability of the farms. Farms with higher capital can generate higher technical-economic performance as well as promote higher sustainability. The diversity can help to reduce risks associated to dairy business.

The third chapter clearly identified some main findings to answer our question. It allowed us to understand the dynamic in milk production systems in Indonesia. Each type of farm had different strategies to ensure family income and to provide milk national market. Farms with limited capital endowment could hardly contribute more to the development of dairy production in Indonesia. To face constraint, some farms added off farm activity. Mixed crop-

livestock systems remain stable in terms of milk production because they manage optimally the resources for two activities. Specialized farms with high capital endowment increased their herd size rapidly. This type contributed more to support national production. In other words, this type might play an important role on the development of dairy production in Indonesia.

From those 3 chapters, we concluded that farmers with higher capital and diversified activity showed better sustainability performances than specialized ones. Specialized farm might play a key role to support national production due to their capacity to rapidly increase their dairy herd. But those specialized farms might be less sustainable than diversified farms. Nevertheless, in order to boost the domestic milk supply, to focus only on specialized farms might not be relevant. It is because the difference in size between small and medium producers is narrow. In addition, due to their high number, small-scale farms are important for the national milk supply, and they are also important for reducing poverty, creating job opportunity, and ensuring nutrition of rural families. In the future, dairy policies should give more emphasis to smallholders' trainings and credit programs. More generally, policy programs should adapt their strategies to each type of farm, in order to better support the farm transition towards sustainable dairy development.

REFERENCES

- Abas, Z., Ragkos, A., Mitsopoulos, I., Theodoridis, A., 2013. The Environmental Profile of Dairy Farms in Central Macedonia (Greece). *Procedia Technol.* 8, 378–386. <https://doi.org/10.1016/j.protcy.2013.11.050>
- Altieri, M.A., Koohafkan, P., Third World Network, 2008. Enduring farms: climate change, smallholders and traditional farming communities. Third World Network (TWN), Penang.
- Andersen, E., Elbersen, B., Godeschalk, F., Verhoog, D., 2007. Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. *J. Environ. Manage.* 82, 353–362. <https://doi.org/10.1016/j.jenvman.2006.04.021>
- Anggraeni, A., Hasibuan, S., Malik, B., Wijaya, R., 2013. Improving The Quality of Tofu Waste as A Source of Feed Through Fermentation Using the *Bacillus amyloliquefaciens* Culture. *Int. J. Adv. Sci. Eng. Inf. Technol.* 3, 285. <https://doi.org/10.18517/ijaseit.3.4.305>
- Antari, R., Umiyasih, U., 2009. Optimizing The Use of Cassava Plant and its Byproduct as Ruminant Feed. *War. Indones. Bull. Anim. Vet. Sci.* 19, 191–200.
- Astier, M., García-Barrios, L., Galván-Miyoshi, Y., González-Esquivel, C.E., Masera, O.R., 2012. Assessing the Sustainability of Small Farmer Natural Resource Management Systems. A Critical Analysis of the MESMIS Program (1995-2010). *Ecol. Soc.* 17. <https://doi.org/10.5751/ES-04910-170325>
- Astuti, M., Widiati, R., Suranindyah, Y.Y., 2010. Efisiensi Produksi Usaha Sapi Perah Rakyat (Studi Kasus pada Peternak Anggota Koperasi Usaha Peternakan dan Pemerahan Sapi Perah Kaliurang, Sleman, Yogyakarta)(Production Efficiency of Smallholder Dairy Cattle Farming (Case Study on The Farmer Members of. *Bul. Peternak.* 34, 64–69.
- Atuhaire, A.M., Mugerwa, S., Kabirizi, J.M., Okello, S., Kabi, F., 2014. Production Characteristics of Smallholder Dairy Farming in the Lake Victoria Agro-ecological Zone, Uganda. *Front. Sci.* 4, 12–19.
- Baccar, M., Bouaziz, A., Dugué, P., Le Gal, P.-Y., 2016. Shared environment, diversity of pathways: dynamics of family farming in the Saïs Plain (Morocco). *Reg. Environ. Change.* <https://doi.org/10.1007/s10113-016-1066-4>
- Badan Pusat Statistik, 2015. Statistik Perusahaan Peternakan Sapi Perah. Jakarta
- Badan Pusat Statistik, 2013. Sensus Pertanian 2013. Jakarta
- Badan Pusat Statistik Kabupaten Bandung Barat, 2016. Bandung Barat dalam Angka tahun 2016, Bandung Barat.
- Badan Pusat Statistik Kabupaten Subang, 2016. Subang dalam Angka tahun 2016, Subang.
- Badan Pusat Statistik Kabupaten Subang, 2014. Kecamatan Ciater dalam Angka tahun 2014, Subang.
- Badan Standardisasi Nasional. 2009. Pakan Konsentrat Sapi SNI 3148.1: 2009, Badan Standardisasi Nasional, Jakarta.
- Barbier, J.-M., Lopez-Ridaura, S., 2010. EVALUATION DE LA DURABILITE DES SYSTEMES DE PRODUCTION AGRICOLES: LIMITES DES DEMARCHES NORMATIVES ET VOIES D'AMELIORATION, in: ISDA 2010. Cirad-Inra-SupAgro, p. 9–p.
- Barbieri, C., 2010. An importance-performance analysis of the motivations behind agritourism and other farm enterprise developments in Canada. *J. Rural Community Dev.* 5.
- Barbieri, C., Mahoney, E., 2009. Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers. *J. Rural Stud.* 25, 58–66. <https://doi.org/10.1016/j.jrurstud.2008.06.001>
- Barbieri, C., Mahoney, E., Butler, L., 2008. Understanding the nature and extent of farm and ranch diversification in North America. *Rural Sociol.* 73, 205–229.
- Barnes, A.P., Hansson, H., Manevska-Tasevska, G., Shrestha, S.S., Thomson, S.G., 2015. The influence of diversification on long-term viability of the agricultural sector. *Land Use Policy* 49, 404–412. <https://doi.org/10.1016/j.landusepol.2015.08.023>

- Barrett, C., Reardon, T., Webb, P., 2001. Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy* 26, 315–331. [https://doi.org/10.1016/S0306-9192\(01\)00014-8](https://doi.org/10.1016/S0306-9192(01)00014-8)
- Begon, M., Pailleux, J.Y., Joly, N., Lémery, B., Dedieu, B., 2009. Les chemins pour durer en élevage bovin laitier: diversité des logiques d'action sur le long terme en Ségala (Massif central). *Renc Rech Rum* 16, 105–108.
- Bhende, M.J., Venkataram, J.V., 1994. Impact of diversification on household income and risk: a whole-farm modelling approach. *Agric. Syst.* 44, 301–312.
- Corniaux C., Alary V., Gautier D., Duteurtre G., 2012 : « Producteur laitier en Afrique de l'Ouest : une modernité rêvée par les techniciens à l'épreuve du terrain », *Autrepart* (62), 2012, p. 17-36 <http://dx.doi.org/10.3917/autr.062.0017>
- Cortez-Arriola, J., Rossing, W.A.H., Massiotti, R.D.A., Scholberg, J.M.S., Groot, J.C.J., Tiftonell, P., 2015. Leverages for on-farm innovation from farm typologies? An illustration for family-based dairy farms in north-west Michoacán, Mexico. *Agric. Syst.* 135, 66–76. <https://doi.org/10.1016/j.agsy.2014.12.005>
- Cots-Folch, R., Martínez-Casasnovas, J.A., Ramos, M.C., 2009. Agricultural trajectories in a Mediterranean mountain region (Priorat, NE Spain) as a consequence of vineyard conversion plans. *Land Degrad. Dev.* 20, 1–13. <https://doi.org/10.1002/ldr.856>
- Daloğlu, I., Nassauer, J.I., Riolo, R.L., Scavia, D., 2014. Development of a farmer typology of agricultural conservation behavior in the American Corn Belt. *Agric. Syst.* 129, 93–102. <https://doi.org/10.1016/j.agsy.2014.05.007>
- Dasuki, M .A . 1983 . Perspektif Perkembangan Peternakan Sapi Perah sebagai Landasan Kesepadanan Mengisi Kebutuhan Susu di Jawa Barat. Disertasi . Universitas Padjadjaran, Bandung.
- Dedieu, B., 2009. Qualification of the adaptive capacities of livestock farming systems. *Rev. Bras. Zootec.* 38, 397–404.
- Devendra, C., 2001. Smallholder dairy production systems in East and South-East Asia: Expanding importance, environmental impacts and opportunities for improvements. *Smallhold. Dairy Prod. Mark. Constraints* 141.
- Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2016. Statistik Peternakan dan Kesehatan Hewan. Kementerian Pertanian Republik Indonesia, Jakarta
- Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2013. Statistik Peternakan dan Kesehatan Hewan. Kementerian Pertanian Republik Indonesia, Jakarta.
- Direktorat Jenderal Peternakan, 1983. Laporan pertemuan pelaksanaan uji coba faktor-faktor penentu dan perencanaan tata penyuluhan subsektor peternakan. Departemen Pertanian, Jakarta.
- Dong, H., Wang, S., Jia, Y., Ni, Y., Zhang, Y., Zhuang, S., Shen, X., Zhao, R., 2013. Long-Term Effects of Subacute Ruminant Acidosis (SARA) on Milk Quality and Hepatic Gene Expression in Lactating Goats Fed a High-Concentrate Diet. *PLoS ONE* 8, e82850. <https://doi.org/10.1371/journal.pone.0082850>
- Duteurtre, G., J.F. Tourrand, I. Vagneron, P. Sembada, Y. Resti, Impact Assesment of Dairy Development Project in Ciater. 2016. Report
- Elsaesser, M., Hernrman K., Jilg T., 2013. The DAIRYMAN-Sustainability-Index (DSI) as a possible tool for the evaluation of dairy farms in North-West Europe. Report
- FAO Regional Office for Asia and the Pacific (Ed.), 2009. Smallholder dairy development: lessons learned in Asia, RAP publication. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.
- FAO, 2017. FAOSTAT Data of Dairy Product. FAO
- Gabbi, A.M., McManus, C.M., Silva, A.V., Marques, L.T., Zanela, M.B., Stumpf, M.P., Fischer, V., 2013. Typology and physical–chemical characterization of bovine milk produced with

- different productions strategies. *Agric. Syst.* 121, 130–134. <https://doi.org/10.1016/j.agsy.2013.07.004>
- García-Arias, A.-I., Vázquez-González, I., Sineiro-García, F., Pérez-Fra, M., 2015. Farm diversification strategies in northwestern Spain: Factors affecting transitional pathways. *Land Use Policy* 49, 413–425. <https://doi.org/10.1016/j.landusepol.2015.08.011>
- García-Martínez, A., Bernués, A., Olaizola, A.M., 2011. Simulation of mountain cattle farming system changes under diverse agricultural policies and off-farm labour scenarios. *Livest. Sci.* 137, 73–86. <https://doi.org/10.1016/j.livsci.2010.10.002>
- García-Martínez, A., Olaizola, A., Bernués, A., 2009. Trajectories of evolution and drivers of change in European mountain cattle farming systems. *animal* 3, 152. <https://doi.org/10.1017/S1751731108003297>
- Gaspar, P., Escribano, M., Mesías, F.J., Ledesma, A.R. de, Pulido, F., 2008. Sheep farms in the Spanish rangelands (dehesas): Typologies according to livestock management and economic indicators. *Small Rumin. Res.* 74, 52–63. <https://doi.org/10.1016/j.smallrumres.2007.03.013>
- Gaspar, P., Mesías, F.J., Escribano, M., Pulido, F., 2009. Sustainability in Spanish Extensive Farms (Dehesas): An Economic and Management Indicator-Based Evaluation. *Rangel. Ecol. Manag.* 62, 153–162. <https://doi.org/10.2111/07-135.1>
- Gaspar, P., Mesías, F.J., Escribano, M., Rodríguez de Ledesma, A., Pulido, F., 2007. Economic and management characterization of dehesa farms: implications for their sustainability. *Agrofor. Syst.* 71, 151–162. <https://doi.org/10.1007/s10457-007-9081-6>
- Gerrard, C.L., Smith, L., Padel, S., Pearce, B., Hitchings, R., Cooper, N., others, 2011. OCIS Public Goods Tool Development.
- GKSI Jawa Barat, 2016. History of GKSI Jawa Barat. (<http://gksi-jawabarat.co.id/>).
- Gressley, T.F., 2014. Inflammatory responses to sub-acute ruminal acidosis, in: 25th Annual Florida Ruminant Nutrition Symposium. University of Florida IFAS Extension, Gainesville. pp. 28–41.
- Gwayumba, W., Christensen, D.A., McKinnon, J.J., Yu, P., 2002. Dry matter intake, digestibility and milk yield by Friesian cows fed two Napier grass varieties. *ASIAN Australas. J. Anim. Sci.* 15, 516–521.
- Häni, F., Braga, F., Stämpfli, A., Keller, T., Fischer, M., Porsche, H., others, 2003. RISE, a tool for holistic sustainability assessment at the farm level. *Int. Food Agribus. Manag. Rev.* 6, 78–90.
- Hansson, H., Ferguson, R., Olofsson, C., Rantamäki-Lahtinen, L., 2013. Farmers' motives for diversifying their farm business – The influence of family. *J. Rural Stud.* 32, 240–250. <https://doi.org/10.1016/j.jrurstud.2013.07.002>
- Hemme, T., Otte, J., FAO, International Farm Comparison Network (Eds.), 2010. Status and prospects for smallholder milk production: a global perspective, Pro-poor Livestock Policy Initiative, a living from livestock. Food and Agriculture Organization of the United Nations, Rome.
- Hennessy, T., Teagasc (Organization), 2013. Measuring farm level sustainability with the Teagasc National Farm Survey.
- Hostiou, N., Dedieu, B., 2012. A method for assessing work productivity and flexibility in livestock farms. *animal* 6, 852–862. <https://doi.org/10.1017/S1751731111002084>
- Hostiou N., Khanh Duy Pham, G. Duteurtre, Vu Trong Bin, B. Dedieu, 2012. “Relationships between work organization and size of dairy farms: a case-study based in Vietnam.”, *Tropical Animal Health and Production*, DOI: 10.1007/s11250-012-0128-y.
- IFCN. 2005. Dairy Report 2005.
- Ikhlef, S., F. Brabez, B. Ziki, A. Bir, and M. Benidir. 2015. Environmental constraints and sustainability of dairy cattle farms in the suburban area of the city of Blida (Mitidja, Algeria). *Afr. J. Agr. Res.* Vol 10 (11).

- Ion, E.R., Călin, I., Răducuță, I., Marin, M.P., Nicolae, C.G., 2015. Research Regarding the Typology of some Sheep Farms which Practicing Conventional Breeding System. *Agric. Agric. Sci. Procedia* 6, 206–210. <https://doi.org/10.1016/j.aaspro.2015.08.060>
- Islam, M.R., Saha, C.K., Sarker, N.R., Jalil, M.A., Hasanuzzaman, M., 2003. Effect of variety on proportion of botanical fractions and nutritive value of different Napiergrass (*Pennisetum purpureum*) and relationship between botanical fractions and nutritive value. *ASIAN Australas. J. Anim. Sci.* 16, 837–842.
- Jia, Y.Y., Wang, S.Q., Ni, Y.D., Zhang, Y.S., Zhuang, S., Shen, X.Z., 2014. High concentrate-induced subacute ruminal acidosis (SARA) increases plasma acute phase proteins (APPs) and cortisol in goats. *animal* 8, 1433–1438. <https://doi.org/10.1017/S1751731114001128>
- Kaouche-Adjlane, S., Ghozlane, F., Mati, A., 2015. Typology of dairy farming systems in the Mediterranean basin (Case of Algeria). *Biotechnol. Anim. Husb.* 31, 385–396. <https://doi.org/10.2298/BAH1503385K>
- Kemenko Perekonomian Republik Indonesia, 2014. Cetak Biru Persusuan Indonesia 2013-2025. Kementerian Koordinator Bidang Perekonomian Republik Indonesia, Jakarta.
- Khanh, K.P.D., Duteurtre, G., Cournot, S., Messad, S., Dedieu, B., Hostiou, N., 2017. Caractérisation de la diversité et de la durabilité des exploitations laitières familiales au Vietnam: étude de cas en zone périurbaine de Hanoï. *Rev. D'élevage Médecine Vét. Pays Trop.* 69, 131–141.
- Kostov, B., Bécue-Bertaut, M., Husson, F., 2013. Multiple Factor Analysis for contingency tables in the FactoMineR package. *R J.* 5, 29–38.
- Kuivanen, K.S., Alvarez, S., Michalscheck, M., Adjei-Nsiah, S., Descheemaeker, K., Mellon-Bedi, S., Groot, J.C.J., 2016. Characterising the diversity of smallholder farming systems and their constraints and opportunities for innovation: A case study from the Northern Region, Ghana. *NJAS - Wagening. J. Life Sci.* 78, 153–166. <https://doi.org/10.1016/j.njas.2016.04.003>
- Landais, É., 1998. Agriculture durable: les fondements d'un nouveau contrat social? *Courr. Environ. INRA* 33, 5–22.
- Le Gal, P.-Y., Kuper, M., Moulin, C.-H., Puillet, L., Sraïri, M.T., 2007. Dispositifs de coordination entre industriel, éleveurs et périmètre irrigué dans un bassin de collecte laitier au Maroc. *Cah. Agric.* 16, 265–271.
- Lebacqz, T., Baret, P.V., Stilmant, D., 2015. Role of input self-sufficiency in the economic and environmental sustainability of specialised dairy farms. *animal* 9, 544–552. <https://doi.org/10.1017/S1751731114002845>
- Lebacqz, T., Baret, P.V., Stilmant, D., 2013. Sustainability indicators for livestock farming. A review. *Agron. Sustain. Dev.* 33, 311–327. <https://doi.org/10.1007/s13593-012-0121-x>
- López-Ridaura, S., Masera, O., Astier, M., 2002. Evaluating the sustainability of complex socio-environmental systems. The MESMIS framework. *Ecol. Indic.* 2, 135–148.
- Madelrieux, S., Terrier, M., Borg, D., Dobremez, L., 2015. Family Dairy Farms in the Northern French Alps: Persistence and Adaptation in a Changing World. *Mt. Res. Dev.* 35, 49–56. <https://doi.org/10.1659/MRD-JOURNAL-D-14-00011.1>
- Madelrieux, S., Terrier, M., Borg, D., Dobremez, L., 2014. Development trajectories of mountain dairy farms in the globalization era. Evidence from the Vercors (French Northern Alps), in: 11th European IFSA Symposium. p. 10–p.
- Malanski, P.D., Hostiou, N., Ingrand, S., 2017. Evolution pathways of employees' work on dairy farms according to task content, specialization, and autonomy. *Cah. Agric.* 26, 65005.
- Marten, G.G., Abdoellah, O.S., 1988. Crop diversity and nutrition in West Java. *Ecol. Food Nutr.* 21, 17–43.
- McNally, S., 2001. Farm diversification in England and Wales—what can we learn from the farm business survey? *J. Rural Stud.* 17, 247–257.

- Meraner, M., Heijman, W., Kuhlman, T., Finger, R., 2015. Determinants of farm diversification in the Netherlands. *Land Use Policy* 42, 767–780. <https://doi.org/10.1016/j.landusepol.2014.10.013>
- Meul, M., Passel, S., Nevens, F., Dessein, J., Rogge, E., Mulier, A., Hauwermeiren, A., 2008. MOTIFS: a monitoring tool for integrated farm sustainability. *Agron. Sustain. Dev.* 28, 321–332. <https://doi.org/10.1051/agro:2008001>
- Moll, H.A.J., Staal, S.J., Ibrahim, M.N.M., 2007. Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka. *Agric. Syst.* 94, 593–603. <https://doi.org/10.1016/j.agsy.2007.02.005>
- Moran, J., 2009. Business management for tropical dairy farmers. Landlinks Press.
- Moran, J., 2005. Tropical dairy farming: feeding management for small holder dairy farmers in the humid tropics. Land Links, Collingwood, VIC, Australia.
- Moulin, C.-H., Ingrand, S., Lasseur, J., Madelrieux, S., Napoléone, M., Pluvinage, J., Thénard, V., 2008. Comprendre et analyser les changements d'organisation et de conduite de l'élevage dans un ensemble d'exploitations: propositions méthodologiques. *Dedieu Al L'élevage En Mouv. Flexibilité Adapt. Exploit. Herbiv.* 181–196.
- Muzayyanah M, Syahlani S, Suranindyah Y. 2013. Profiles of Smallholder Dairy Farmers Groups after Volcanic Eruption Damage in Indonesia : A Case Study of Sleman Regency , Daerah Istimewa Yogyakarta. *J. Int Dev and Co.*, 19(4):121–129
- Nell and Rollinson, 1974. The requirement and availability of livestock feed in Indonesia. FAO. Report
- Nganga S.K., Kungu J., Ridder N., and Herrero M., 2010. Profit efficiency among Kenyan smallholders milk producers: A case study of Meru-South district, Kenya, *Agricultural Resources*, 5, 332-337
- Nkya, R., Kessy, B.M., Lyimo, Z.C., Msangi, B.S.J., Turuka, F., Mtenga, K., 2007. Constraints on smallholder market oriented dairy systems in the north eastern coastal region of Tanzania. *Trop. Anim. Health Prod.* 39, 627–636. <https://doi.org/10.1007/s11250-007-9059-4>
- Nugroho, B.A., 2010. Pasar susu dunia dan posisi Indonesia. *J. Ilmu-Ilmu Peternak.* 20, 65–76.
- Nurtini, S., Muzayyanah, M.A.U., 2014. Profil peternakan sapi perah rakyat di Indonesia. Gadjah Mada University Press.
- Owens, F.N., Secrist, D.S., Hill, W.J., Gill, D.R., 1998. Acidosis in cattle: a review. *J. Anim. Sci.* 76, 275–286.
- Pacini, G.C., Colucci, D., Baudron, F., Righi, E., Corbeels, M., Tiftonell, P., Stefanini, F.M., 2014. Combining multi-dimensional scaling and cluster analysis to describe the diversity of rural household. *Exp. Agric.* 50, 376–397. <https://doi.org/10.1017/S0014479713000495>
- Pages, J., 2004. Multiple factor analysis: Main features and application to sensory data. *Rev. Colomb. Estad.* 27, 1–26.
- Pandian A.S.S., Shree J.S., Raja M.B., and Vetrivel D., 2013. Efficiency of resources use in urban milk production in the state of Tamil Nadu, India, *Vet Sci*, 2(4), 118-120. www.ijvets.com Accessed 18 October 2014
- Poulton, C., Dorward, A., Kydd, J., 2010. The Future of Small Farms: New Directions for Services, Institutions, and Intermediation. *World Dev.* 38, 1413–1428. <https://doi.org/10.1016/j.worlddev.2009.06.009>
- Pretty, J., 2008. Agricultural sustainability: concepts, principles and evidence. *Philos. Trans. R. Soc. B Biol. Sci.* 363, 447–465. <https://doi.org/10.1098/rstb.2007.2163>
- Prihartini, I., Soebarinoto, S., Chuzaemi, S., Winugroho, M., 2011. Nutrient Characteristics and Fermented Rice Straw Degradation by Lignolytic TLiD and BopR Inoculums. *Anim. Prod.* 11, 1–7.
- Priyanti, A., Nurtini, S., Firman, A., 2009. Analisis Ekonomi dan Aspek Sosial Usaha Sapi Perah, in: *Profil Usaha Peternakan Sapi Perah di Indonesia*. LIPI Press, Bogor.

- Rahayu, E.T., 2017. Analisis Pendapatan Usaha Ternak Sapi Perah Di Kecamatan Cepogo Kabupaten Boyolali. *Sains Peternak. J. Penelit. Ilmu Peternak.* 11, 99–105.
- Ripoll-Bosch, R., Díez-Unquera, B., Ruiz, R., Villalba, D., Molina, E., Joy, M., Olaizola, A., Bernués, A., 2012. An integrated sustainability assessment of mediterranean sheep farms with different degrees of intensification. *Agric. Syst.* 105, 46–56. <https://doi.org/10.1016/j.agsy.2011.10.003>
- Riveiro, J.A., Mantecón, A.R., Álvarez, C.J., Lavín, P., 2013. A typological characterization of dairy Assaf breed sheep farms at NW of Spain based on structural factor. *Agric. Syst.* 120, 27–37. <https://doi.org/10.1016/j.agsy.2013.05.004>
- Riveiro, J.A., Marey, M.F., Marco, J.L., Alvarez, C.J., 2008. Procedure for the classification and characterization of farms for agricultural production planning: Application in the Northwest of Spain. *Comput. Electron. Agric.* 61, 169–178. <https://doi.org/10.1016/j.compag.2007.11.003>
- Rohmiyatul Islamiyati, J., A.R, Hidayat, 2010. Nilai Nutrisi Ampas Tahu yang Difermentasi dengan Berbagai Level Ragi Tempe. Presented at the Seminar Nasional Tknologi Peternakan dan Veteriner.
- Rueff, C., Choisis, J.-P., Balent, G., Gibon, A., 2012. A Preliminary Assessment of the Local Diversity of Family Farms Change Trajectories Since 1950 in a Pyrenees Mountains Area. *J. Sustain. Agric.* 36, 564–590. <https://doi.org/10.1080/10440046.2012.672547>
- Ryschawy, J., Choisis, N., Choisis, J.P., Gibon, A., 2013. Paths to last in mixed crop–livestock farming: lessons from an assessment of farm trajectories of change. *animal* 7, 673–681. <https://doi.org/10.1017/S1751731112002091>
- Ryschawy, J., Choisis, N., Choisis, J.P., Gibon, A., 2011. Understanding how farmers last over the long term: a typology of trajectories of change in farming systems. A French case-study, in: *Proceedings of the 62nd EAAP Annual Meeting.*
- Sahabat Cipta Foundation, 2011. Laporan Akhir: Karakteristik peternak sapi perah Ciater, oleh Lembaga Studi Pembangunan Peternakan Indonesia, Bekerjasama dengan, KPSBU Jawa Barat, Yayasan Sahabat Cipta, Danone Dairy Indonesia, Jakarta, 55 p. + Database
- Sajjad, M., & Khan, M. 2010. Economic efficiency of milk production in District Peshawar : a Stochastic Frontier Approach. *Agriculture*, 26(4), 655–663
- Salcedo, A., García-Trujillo, R., 2005. Sheep production systems in the north of Granada province. Case studies. *Options Méditerranéennes* 101–109.
- Sembada, P., Duteurtre, G., Purwanto, B.P., Suryahadi, 2016. Improved milk production performance of smallholder farms in West Java (Indonesia). *Trop. Anim. Health Prod.* <https://doi.org/10.1007/s11250-016-1029-2>
- Speelman, E.N., López-Ridaura, S., Colomer, N.A., Astier, M., Masera, O.R., 2007. Ten years of sustainability evaluation using the MESMIS framework: Lessons learned from its application in 28 Latin American case studies. *Int. J. Sustain. Dev. World Ecol.* 14, 345–361.
- Sraïri, M.T., Benhouda, H., Kuper, M., Le Gal, P.Y., 2009. Effect of cattle management practices on raw milk quality on farms operating in a two-stage dairy chain. *Trop. Anim. Health Prod.* 41, 259–272. <https://doi.org/10.1007/s11250-008-9183-9>
- Subandriyo, Adiarto, 2009. Sejarah Perkembangan Peternakan Sapi Perah, in: *Profil Usaha Peternakan Sapi Perah di Indonesia.* LIPI Press, Puslitbangnak, Bogor.
- Sudaryanto, B., Hermawan, A., 2014. Prospek Pengembangan Sapi Perah di Indonesia, in: *Reformasi Kebijakan Menuju Transformasi Pembangunan Pertanian.* IAARD Press, Badan Penelitian dan Pengembangan Pertanian.
- Suess-Reyes, J., Fuetsch, E., 2016. The future of family farming: A literature review on innovative, sustainable and succession-oriented strategies. *J. Rural Stud.* 47, 117–140. <https://doi.org/10.1016/j.jrurstud.2016.07.008>

- Sulastri, E., Maharjan, K.L., 2002. Role of dairy cooperative services on dairy development in Indonesia a case study of Daerah Istimewa Yogyakarta Province. *J. Int. Dev. Coop.* 9, 17–39.
- Taslim. 2011. Pengaruh faktor produksi susu usahaternak sapi perah melalui pendekatan analisis jalur di Jawa Barat. *Ilmu Ternak*, 1(10), 52–56
- Tawaf, R., Murti, T., Saptati, R., 2009. Kelembagaan dan Tata Niaga Susu, in: *Profil Usaha Peternakan Sapi Perah di Indonesia*. LIPI Press, Puslitbangnak, Bogor.
- Tawaf, R., & Surianingrat, A. S. 2010. *The Role of Demo Farm to Develop Small Holder*, (p. 5), Bandung
- Tebug, S.F., Kasulo, V., Chikagwa-Malunga, S., Wiedemann, S., Roberts, D.J., Chagunda, M.G.G., 2012. Smallholder dairy production in Northern Malawi: production practices and constraints. *Trop. Anim. Health Prod.* 44, 55–62. <https://doi.org/10.1007/s11250-011-9887-0>
- Thenail, C., 2002. Relationships between farm characteristics and the variation of the density of hedgerows at the level of a micro-region of bocage landscape. Study case in Brittany, France. *Agric. Syst.* 71, 207–230.
- Toro-Mujica, P., García, A., Perea, J., de Pablos-Heredero, C., Barba, C., Angón, E., 2014. Sustentabilidad del sistema ovino ecológico lechero en Castilla la Mancha (España). *Rev. Científica Fac. Cienc. Vet.* 24, 553–563.
- Van Cauwenbergh, N., Biala, K., Biolders, C., Brouckaert, V., Franchois, L., Garcia Ciudad, V., Hermy, M., Mathijs, E., Muys, B., Reijnders, J., Sauvenier, X., Valckx, J., Vanclooster, M., Van der Veken, B., Wauters, E., Peeters, A., 2007. SAFE—A hierarchical framework for assessing the sustainability of agricultural systems. *Agric. Ecosyst. Environ.* 120, 229–242. <https://doi.org/10.1016/j.agee.2006.09.006>
- Van Passel, S., Meul, M., 2012. Multilevel and multi-user sustainability assessment of farming systems. *Environ. Impact Assess. Rev.* 32, 170–180.
- Weil, R.R., 1990. Defining and using the concept of sustainable agriculture. *J Agron Educ* 19, 126–130.
- Zahm, F., Viaux, P., Girardin, P., Vilain, L., Mouchet, C., Environnement, F., 2007. Farm Sustainability Assessment using the IDEA Method From the concept of farm sustainability to case studies on French farms. *Common Princ. Common Pract.* 77.

ANNEXES

1. Questionnaire for chapter 1

I. Farmer's identity and organisation

1. Name :
2. Status in Household:
3. Address :
4. GPS :
5. Group of farmers:
6. Age :
7. Date of visit :
8. Education level:

II. Physical Capital

1. Ownership of Herd

No.	Livestock	Number of Herd	Breed	Value (IDR)
1.	Dairy Cattle			
1.1	Lactating Cow			
1.2	Cow on Dry Period			
1.3	Heifer			
1.4	Male Calf			
1.5	Female Calf			
1.6	Bull			
2.	Beef Cattle			
2.1	Bull			
2.2	Cow			
2.3	Calf			
3.	Poultry			
3.1	Layer			
3.2	Broiler			
3.3	Quail			

3.4	Native Chicken			
3.5	Ducks			
4.	Small Ruminant			
4.1	Goat			
4.2	Sheep			
5.	Others			
.....			
.....			

2. Barns and facilities

Type of Barn	Yes : 1 No : 0	Roof (see code)	Floor (see code)	Material Structure (see code)	Biogas (Yes: 1 No: 0)	Value (IDR)
Demo Farm						
A la Carte						
Communal Barn						
Others						

Roof Code : 1: roof tile; 2: asbestos; 3: Zinc; 4: others

Floor Code : 1. Soil; 2: wood; 3: concrete; 4: others

Material Structure : 1. Wood; 2: concrete; 3: Mix; 4: others

Facilities	Yes: 1 No: 0	Information	Value (IDR)
Drainage			
Milking machine			
Milking bucket			
Milkcan			

Milk filter			
Teat dipping			
Equipment for cleaning barn			
Others (.....)			

3. Land ownership

Category	Area	Status (see code)
Residential		
Barns		
Pasture (natural and planted)		
Managed forests		
Cropland		
Plantation		
Others		
Total Land		

1= own land

2= rent land

If rent land, how much do you spent on rent/month (IDR)?

.....

III. Farming Practice Aspects

1. Labor Organisation and Procedures

Activities	Activitiy done 1 = yes 0 = no	Main people doing the activity (see code)	Number of worker	Number of hours/person/day

Forage preparation and cutting				
Milking				
Cleaning barn				
Cleaning the animal				
Planting, weeding, and manuring forage				
Transforming milk				
Supplying milk				
Others				

1 = Household head; 2 = Adult Males (other than HH head); 3 = Adult Females (other than HH head); 4 =Spouse; 5 = Any Household member; 6 = Children; 7 = Long-term labourers; 8 = Casual labourers; 9 = Any Adult in Household; 10=Other (specify).....

2. Techniques and Inputs

2.1 Composition of feed ratio

Category	Number of feed (kg)/day
1. Forage	
1.1 King grass	
1.2 Elephant Grass	
1.3 Natural Grass	
2. Concentrate	
3. Mineral mix	
4. Agriculture by product	
5. Others (Specify)	

2.2 Cow genetic

Breeding of Dairy Cattle:

- a. Pure breed Friesian Holstein
- b. Cross breed
- c. Others (.....)

2.3 Quantity of water consumption

- a. Ad libitum b. Two times/day c. Unmanaged

2.4 Vaccination

Number of vaccination per cow/year:

- a. Two times/year b. once/year c. Never d. Others (.....)

Type of vaccination:

2.5 Mating System

- a. Artificial Insemination
 b. Natural Mating with qualified bull
 c. Natural mating with unqualified bull

If using Artificial Insemination, how many AI service/cow?

3. Performance of the Herd

3.1 Milk Production and quality

Total milk production/day/farm =

Total milk deliver to cooperative (in a week) = (see data from cooperative)

3.2 Milk productivity

Total quantity of milk produced/day/lactating cow =

Total quantity of milk produced/day/total cow =

Cow (example)	Age	Lactation level	Production of milk (litter)	Quality of milk
1				TPC: Fat: SNF:

3.3 Mortality of Cows

How many cows are dead (cow/year)?

3.4 Calving Interval

- a. One year b. 1-1,5 year c. >1,5 year

3.5 Period of Milking Cows

- a. 10 months b. 10,5 months c. <10 months d. >10,5 months

IV. Economic Activities

1. Organization of Economic Activities

Organization of economic activities	Yes : 1 No : 0	Priority scale of economic activity (1-5) 1 = most prioritized 5 = less prioritized	Income/month (IDR)	Number of workers at household
Dairy farming				
Livestock farming (non dairy)				
Crop farming				
Formal employment				
Trade				
Labour				
Pension				
Others (.....)				

2. Dairy Bussiness

Revenue	Monetary (IDR)	Non monetary (IDR)	Total (IDR)
1. Value of cattle (end year) (+)			
2. Value of cattle (start year) (-)			
3. Product (+)			
4. Selling cattle (+)			

5. Purchasing cow (-)			
6. Waste value (+)			
Cost of dairy farming			
Variable cost			
1. Feed			
2. Labour			
3. Medecine			
4. Water, electricity,			
5. Equipment			
6. Others			
.....			
.....			
Fixed cost			
1. Rent land			
2. Rent barn			
3. Others			
.....			
.....			

Raw income = Revenue – cost

Net income = Raw income – (Tax+interest+family labor+Depreciation)

Household income = Net income + income from other sources

3. Would you say your income has increased, decreased, or remained the same compared to years before the project?.....

4. How much the increased or decreased?.....

5. Why it is happened?.....

V. Knowledge and skills of farmer

1. What skills and/or knowledge did you learn during the training?

- a.
- b.
- c.
- d.
- e.

Explain

.....
.....
.....

2. Were the skills and/or knowledge obtained during training useful?

Yes, explain

.....
.....
.....

No, explain

.....
.....
.....

3. Are you putting to use what you learned during training?

Yes, explain

.....
.....
.....

No, explain

.....
.....
.....

4. What changes have resulted as a result of the trainings that you participated?

.....

VI. Additional question

1. History of Farm

1.1 When you have started the dairy farming?

.....

1.2 Before dairy farming, what activity did you have?

a. labour b. Plantation c. Cropping d. Did not work e. Others

1.3 How many cattle at the first time?.....

1.4 Where you have got the cattle?

a. Credit scheme of the project

b. Heritage

c. Credit scheme of non project

d. Assistance from

e. Others

1.5 The explanation of the history

.....

2. Member of Association

2.1 Do you a member of group farmer, association, or other?

a. group farmer : a. Yes b. No

b. association : a. Yes b. No;

If yes what kind of association: a. Cooperative b. Other

3. Participation of meeting group farmer

3.1 Have you participated in the meeting group farmer on the last year, last three months, and last month?

a. Yes b. No

3.2 How many times that you have participated?

In the last year = a. > 10 times b. 5-10 times c. < 5 times

In the last three months = a. >3 times b. 1-2 times c. Never

In the last month = a. > one time b. Once c. Never

4. Participation of the training

4.1 Have you participated in the training on the last three years?

a. Yes b. No

4.2 What training did you participate?

Training participated	Trained by 1=Project 2=government 3=others	How many times	How was the training delivered 1= workshop 2= demonstration 3= farmer to farmer visit 4= other

Code training:

1= Good Farming practice (feeding, rearing, animal health, housing, breeding, etc)

2 = Good Milking process and Quality of Milk

3 = new technics (feed processing, milk processing, etc)

4 = bussiness development

5 = others

Appendix 2 Scoring of Barn Condition (Directorate General of Livestock 1983)

No.	Indicator	Score
1.	Layout of barn	
	a. separate	10
	b. non-separated from house	5
2.	Barn construction	
	a. qualified	25
	b. less qualified	15
	c. not eligible	5
3.	Drainage	
	a. good	15
	b. average	10
	c. not good	5
4.	Place for waste	
	a. good	10
	b. not good	5
	c. nothing	2
5.	Barn equipment	
	a. complete	15
	b. less complete	10
	c. not complete	5
6.	Milking equipment	
	a. complete and qualified	25
	b. less complete and less qualified	15
	c. not complete	5
Total Score		100

2. Questionnaire for chapter 2

MILK FARMER SURVEY

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Quest. No.

Remarks:

A Identification

<p>A0. Date: _____</p> <p>A1. Name of the enumerator: _____</p> <p>A2. Name of the farmer: _____</p> <p>A3. Name of cooperative: _____</p> <p>A4. Number of the TPS: _____</p> <p>A5. Name of the TPK: _____</p> <p>A6. Farmer membership No.: _____</p> <p>A7. Altitude (in m) _____</p>	<p>A8. Name of the village: _____</p> <p>A9. Name of the Hamlet: _____</p> <p>A10. Distance to the collection point (meters): _____</p> <p>A11. Do you have a renovated feed alley +water trunk? <input type="checkbox"/> 0.No <input type="checkbox"/> 1.Yes</p> <p>A12. Was it done by the Danone project? <input type="checkbox"/> 0.No <input type="checkbox"/> 1.Yes</p> <p>A13. Do you train other farmers? <input type="checkbox"/> 0.No <input type="checkbox"/> 1.Yes</p>
---	--

B. Household characteristics

B1. Household composition

B1.1 No of children _____

B1.2 No. of adults (including yourself) _____

B2. How old are you? _____

B3. Gender 1.Male 2.Female

B4. What is your level of education?

<input type="checkbox"/> 0. No education	<input type="checkbox"/> 1. Some primary	<input type="checkbox"/> 2. Completed primary
<input type="checkbox"/> 3. Some secondary	<input type="checkbox"/> 4. Completed secondary	<input type="checkbox"/> 5. Some high school/vocat.
<input type="checkbox"/> 6. Completed high school/vocational	<input type="checkbox"/> 7. Some university	<input type="checkbox"/> 8. Completed university

B5. Are you Sundanese? 0. No 1. Yes

B6. What year did you start raising cows? _____

C Farming Activity

C1. Physical Capital

1	The herd	Livestock	a.2010	2015	
				b. Owned animal	c. Shared animals
		C1.1.1 Lactating Cow	<input type="text"/>	<input type="text"/>	<input type="text"/>
		C1.1.2 Cow on dry period	<input type="text"/>	<input type="text"/>	<input type="text"/>
		C1.1.3 Heifer	<input type="text"/>	<input type="text"/>	<input type="text"/>
		C1.1.4 Male calf	<input type="text"/>	<input type="text"/>	<input type="text"/>
		C1.1.5 Female calf	<input type="text"/>	<input type="text"/>	<input type="text"/>

C1.1.6 Bull	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.1.7 Beef cattle	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.1.8 Chicken	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.1.9 Others	<input type="text"/>	<input type="text"/>	<input type="text"/>

C1.2 Land-access and land use

Category	a. Rented area (m ²)	b. Owned area (m ²)	c. Rental cost (Rp./m ² /year)
C1.2.1 Residential	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.2.2 Barns	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.2.3 Forage (cropping land)	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.2.4 Forage (forest land)	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.2.5 Horticulture	<input type="text"/>	<input type="text"/>	<input type="text"/>
C1.2.6 Other crops	<input type="text"/>	<input type="text"/>	<input type="text"/>

C1.3 Barn construction and material (observation)

C1.3.1 ROOF	<input type="checkbox"/> 1. tiled roof	<input type="checkbox"/> 2. asbestos roof	<input type="checkbox"/> 3. zinc roof	<input type="checkbox"/> 99. Other	_____
C1.3.2 STRUCTURE	<input type="checkbox"/> 1. wood	<input type="checkbox"/> 2. concrete	<input type="checkbox"/> 3. mix	<input type="checkbox"/> 99. Other	_____
C1.3.3 FLOOR	<input type="checkbox"/> 1. soil	<input type="checkbox"/> 2. wood	<input type="checkbox"/> 3. concrete	<input type="checkbox"/> 99. Other	_____
C1.3.4 WASTE MGT	<input type="checkbox"/> 1. waste pit	<input type="checkbox"/> 2. waste water in river	<input type="checkbox"/> 3. biogas unit	<input type="checkbox"/> 99. Other	_____

C1.4 What facilities do you have in your farm?

<input type="checkbox"/> 1. Milking machine	<input type="checkbox"/> 2. Milking bucket	<input type="checkbox"/> 3. Milk can
<input type="checkbox"/> 4. Milk filter	<input type="checkbox"/> 5. Teat dipping	<input type="checkbox"/> 6. Equipt for cleaning barn
<input type="checkbox"/> 7. Carpets	<input type="checkbox"/> 8. Balances	<input type="checkbox"/> 9. Measuring meter
<input type="checkbox"/> 99. Other	_____	

C2. Labor organization and procedures

Activities	a. Activity done	b. No. Of hours /worker/day	c. No. of HH workers	d. No. of outside workers
C2. 1 Forage transportation and cutting	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.2 Milking	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.3 Cleaning the barn	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.4 Cleaning the animals	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.5 Planting & fertilizing forage	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.6 Processing milk at home	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.7 Supplying milk and cleaning cans	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____
C2.8 Others _____	<input type="checkbox"/> 0. No <input type="checkbox"/> 1. Yes	_____ / _____ / _____	_____	_____

C2.9 How many people of your household work on the farm? _____

C3. Techniques and Input

C3. 1 How much of the following feeds do you give your animals (time of survey)?

Category	Amount of feed (kg/cow/day)
C3.1.1 Nappier grass	_____ / _____ / _____
C3.1.2 King grass	_____ / _____ / _____
C3.1.3 Natural grass	_____ / _____ / _____
C3.1.4 Banana trunks	_____ / _____ / _____
C3.1.5 Rice straw	_____ / _____ / _____
C3.1.6 Concentrate	_____ / _____ / _____
C3.1.7 Mineral mix	_____ / _____ / _____

C3.1.8 Cassava waste	_____ / _____ / _____
C3.1.9 Rice bran	_____ / _____ / _____
C3.1.10 Tofu waste	_____ / _____ / _____
C3.1.11 Other _____	_____ / _____ / _____

C3.2 What is your dairy cattle breed? 1. Pure breed FH 2. crossbreed FH 99. Other

C3.3 In 2015, how is your water trunk refilled? 1. Automatically 2. Manually (twice a day) 3. Manually / unmanaged

C3.4 In 2010, how did you give water to your cows? 1. Automatically 2. Manually (twice a day) 3. Manually / unmanaged

C3.5 Mating system 1. Artificial insemination 2. Natural mating with bull

C3.5.1 Over the past 12 months, on average, how many insemination services were performed per cow ? _____

C3.6 Calving interval 1. one year 2. (1F1.5 years) 3. > 1.5 years

C3.7 Average lactation period of milking cows 1. ten month 2. < ten month 3. > ten month

C3.8 What is your total milk production / day today ? _____

C3.9 What was your total milk production / day in 2010? _____

C3.10 Do you plan to have more cows ? 0. No 1. Yes

C3.11 According to you, what are the main constraints to the expansion of yo tick all relevant, propose if#needed

1. I don t have enough land for forage 2. I don t have enough labor

3. I don t have enough money 4. I don t have enough space in the barn

5. I am satisfied with my farm 6. Income from selling calves is what I need

99. Other _____

C4. What kind of waste does your farm prod tick all relevant, propose if needed 1. solid manure 2. liquid manure 3. Feed waste

C5. What do you do with the wast tick all relevant, propose if needed

1. Evacuation of all wastes to the river / surroundings 2. Evacuation of only part of wastes to river

3. Solid part used as organ. fertilizer (transp. to the plot) 4. Solid part sold to neirboughring famers

5. Liquid part used as organic fertilizer (evacuated to the plot) 6. Biogas in use

C6 Have you changed your waste management practices since 2010? 0. No 1. Yes

C6.1 If yes: What did you change ? _____

C7. Do you have waste management problem? 0. No 1. Yes

C8.1 Does the surveyor see any waste management problem? 0. No 1. Yes

C 8.2 If yes , what is it? 1. Problem of smell 2. Problem of environmental pollution

D Economic aspects

D1. Net KPSBU revenue (past 15 days) _____

D2. Non KPSBU dairy related revenues (last 12 months)

Items	a. Quantity	b. Price/unit (Rp.)	c. Total income (Rp./year)
D2.1 Calves	_____	_____	_____
D2.2 Cows	_____	_____	_____
D2.3 Manure	_____	_____	_____
D2.4 Processing milk	_____	_____	_____

D3. Non KPSBU costs (last 12 months)

These are costs that incur outside KPSBU (not on the sheet)

Costs	a. Quantity	b. Cost/unit (Rp.)	c. Total cost (Rp./year)
D3.1 Fertilizers (kg)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.2 Tofu waste (kg)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.3 Cassava waste (kg)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.4 Fodder (kg)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.5 Rice straw (kg)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.6 Labour (person)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.7 Medicine (number)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.8 Electricity	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.9 Land (m ²)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.10 Purchasing cattle (number)	<input type="text"/>	<input type="text"/>	<input type="text"/>
D3.11 Equipment (number)	<input type="text"/>	<input type="text"/>	<input type="text"/>

D4. Household economic activities

Activities	a. Income/year	b. No of HH members
D4.1 Other farming activities	<input type="text"/>	<input type="text"/>
D4.2 Wage work	<input type="text"/>	<input type="text"/>
D4.3 Business	<input type="text"/>	<input type="text"/>
D4.4 Remittances	<input type="text"/>	<input type="text"/>
D4.5 Pensions	<input type="text"/>	<input type="text"/>
D4.6 Other	<input type="text"/>	<input type="text"/>

E Knowledge and Trainings

E1. Do you know SahabatYCIpta?

 0. No 1. YesIf yes

E1.1 Did you hear about actions being undertaken by SahabatYCIpta in your neighborhood?

 0. No 1. Yes

E1.2 Did SahabatYCIpta contact you between 2011 and 2014?

 0. No 1. Yes

E2. Did you hear about the renovated feed bunk and drink system?

 0. No 1. Yes

E3. Do you have one?

 0. No 1. YesIf yes

E3.1 Since when (MM/YY)?

/

E3.2 How did you have the idea?

 1. From my neighbor 2. From SahabatFCipta 3. From KPSBU

E4. Since 2011, has any member of your household received training on good farming practice?

 0. No 1. YesIf yes

E4.1 From who?

 1. KPSBU 2. Sahabat F Cipta 3. KPSBU & SahabatF Cipta

E4.2 When did you start receiving this training? (MM/YY)

/

E4.3 How many trainings were provided?

/

E4.4 When did you have the last training (MM/YY)?

/

E5. Between 2011 and 2014 how often did neighboring farmers come to your house to be trained on good farming practice?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E6. Since 2015, how often did neighborhood farmers come to your house to train on good farming practice?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E7. Between 2011 and 2014, how often did you visit a model farm?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E8. Since 2015, how often do you go visit a demoYfarm?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E9. Between 2011 and 2014, how often did you receive training in a demoYfarm?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E10. Since 2015, how often do you receive training in a demoYfarm?

0. Never 1. Daily 2. Weekly 3. Monthly 4. Less often than monthly

E11. Do you know how to make silage?

0. No 1. Yes

E12. Did you know how to make silage before 2010?

0. No 1. Yes

E13. Did a government officer come to your farm to provide you training on dairy practices?

0. No 1. Yes

If yes E13.1 When? (MM/YY) _____ / _____

E14. Did you receive cattle from the government?

0. No 1. Yes

If yes E14.1 When (year) _____

E14.2 How many? _____

E15. Do you know Danone?

0. No 1. Yes

E16. Did you know Danone before 2011?

0. No 1. Yes

F Indicators of wellbeing

F1. Type of tenure of the house

1. Owned 2. Rented 99. Other _____

F2. Do you have access to tap water?

0. No 1. Yes

F3. What do you use electricity for?

1. Lighting 2. Air conditioning 3. Cooking 4. Water heating 5. House appliances 99. Other

F4. Do you use biogas?

0. No 1. Yes

If yes F4.1 What do you use biogas for?

1. Lighting 2. Heating 3. Cooking 99. Other

F5. Housing characteristics

	a. 2015		b. 2010	
F5.1 Brick/concrete walls	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No
F5.2 Tiled roof	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No
F5.3 Garage	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No

F6. How many of the following equipment do you have in your household?

- F6.1 Do you have a radio 1. Yes 0. No F6.1.1 Since (year) _____
- F6.2 Do you have a television 1. Yes 0. No F6.2.1 Since (year) _____
- F6.3 Do you have a refrigerator? 1. Yes 0. No F6.3.1 Since (year) _____
- F6.4 Do you have a washing machine? 1. Yes 0. No F6.4.1 Since (year) _____
- F6.5 Do you have a mobile phone? 1. Yes 0. No F6.5.1 Since (year) _____
- F6.6 Do you have a CD player? 1. Yes 0. No F6.6.1 Since (year) _____
- F6.7 Do you have a motorcycle? 1. Yes 0. No F6.7.1 Since (year) _____
- F6.8 Do you have a car / pickUp truck? 1. Yes 0. No F6.8.1 Since (year) _____
- F6.9 Do you have a bicycle? 1. Yes 0. No F6.9.1 Since (year) _____

F7. In 2015, how much did you pay for your childrens school fees?

F7.1 No. of children in school age _____

F7.2 No. of children going to school _____

G Perception of wellbeing

G1. Compared to 2010, how did your financial situation evolve?

propose#the#answers

1. It improved a lot
 2. It somewhat improved
 3. It remained unchanged
 4. It somewhat deteriorated
 5. It deteriorated a lot
 6. Does not know

G2. Compared to 2010, would you say that you are:

propose#the#answers

1. Much happier
 2. A little happier
 3. The same
 4. A little unhappier
 5. Much unhappier

G3. What do you think about milk farming in general

propose#the#answers

1. It is a very good business
 2. It is an OK business
 3. It is neither a good or a bad business
 4. It is a bad business
 5. It is a very bad business

G4. Would you say that you were impacted by the Danone project?

0. No 1. Yes

If Yes G4.1 What impact did the project have on your community? propose the answers and tick all relevant

1. It created solidarity 2. It enhanced competition 3. It created jealousy
 4. It created pride 5. It increased our knowledge 6. It increased our confidence
 7. It strengthened community ties 99. Other _____

If ticked YES at A12 and/or A13

ask:

G5. How did being part of the DDCP project change your mindset about dairy farming?

1. I can project myself in the future 2. I take more risks 3. I innovate more 4. I'm less worried
 99. Other _____

G6. Would you like your children to continue your farm?

0. No 1. Yes 2. It's up to them

H Y Social Capital

H1. Are you a member of any other association/ group?

Type of association	a. Ordinary member		b. Do you have responsibilities?	
H1.1 Informal credit group / Arissan	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes
H1.2 Church/ Mosque	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes
H1.3 Women's group	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes
H1.99 Other _____	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	<input type="checkbox"/> 1. Yes

H2. Do you have special responsibilities in the village?

0. No 1. Yes

If yes

H2.1 What kind?

1. village head 2. village teacher 3. Imam 99. Other _____

H3. Are you a member of KPSBU?

0. No 1. Yes

If yes

H3.1 Since when?

Year: _____

If no

H3.2 Were you ever a member?

0. No 1. Yes

If yes

H3.2.1 When did you drop out?

Year: _____

H3.2.2 Why did you drop out? _____

I Credit information

11. Did you have access to credit in cash before 2011?

0. No 1. Yes

If yes I1.1 Where did you borrow money from?

1. Bank 2. Family/friends 3. Arisan 4. KPSBU

5. Trader or collector 99. Other _____

12. Do you have access to credit in cash now?

0. No 1. Yes

If yes I2.1 Where do you borrow the money from?

1. Bank 2. Family/friends 3. Arisan

4. Project Danone 99. Other _____

I2.2 Does KPSBU help you get the loan ?

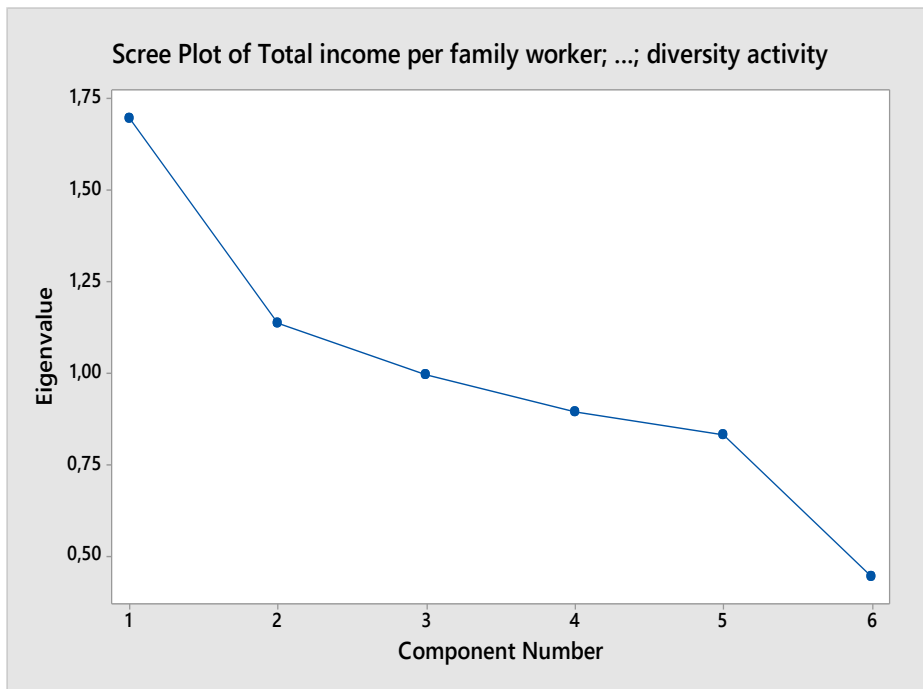
0. No 1. Yes

13. Do you have a bank account?

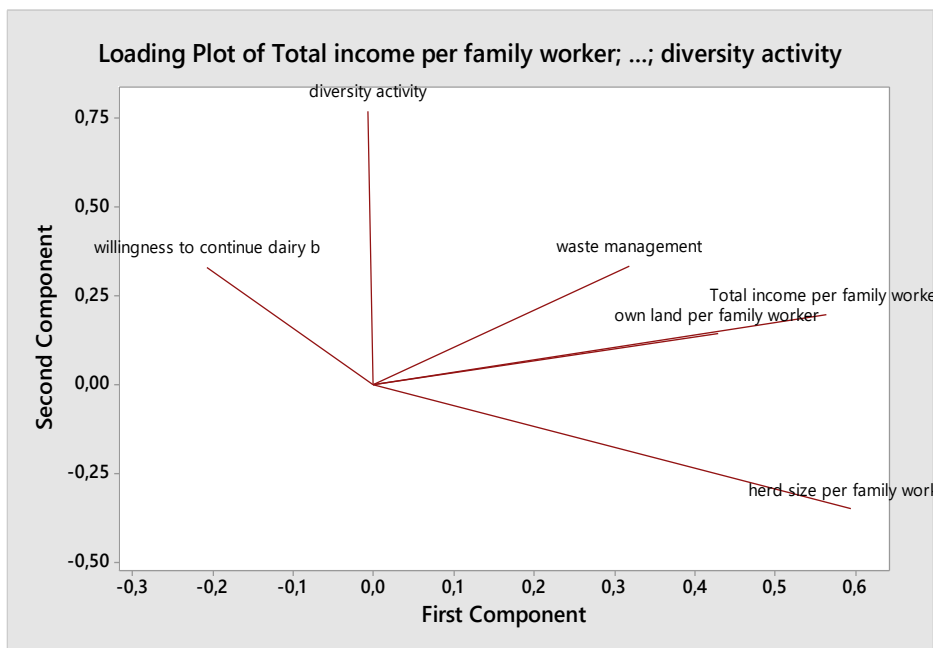
0. No 1. Yes

3. Multivariate analysis for pattern of sustainability

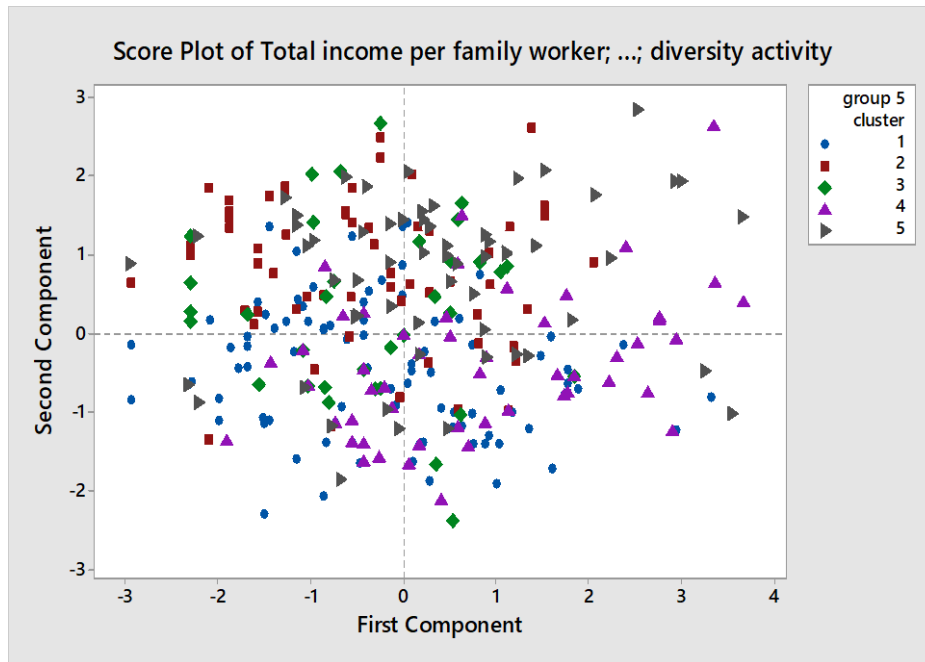
Principal Component Eigenvalue



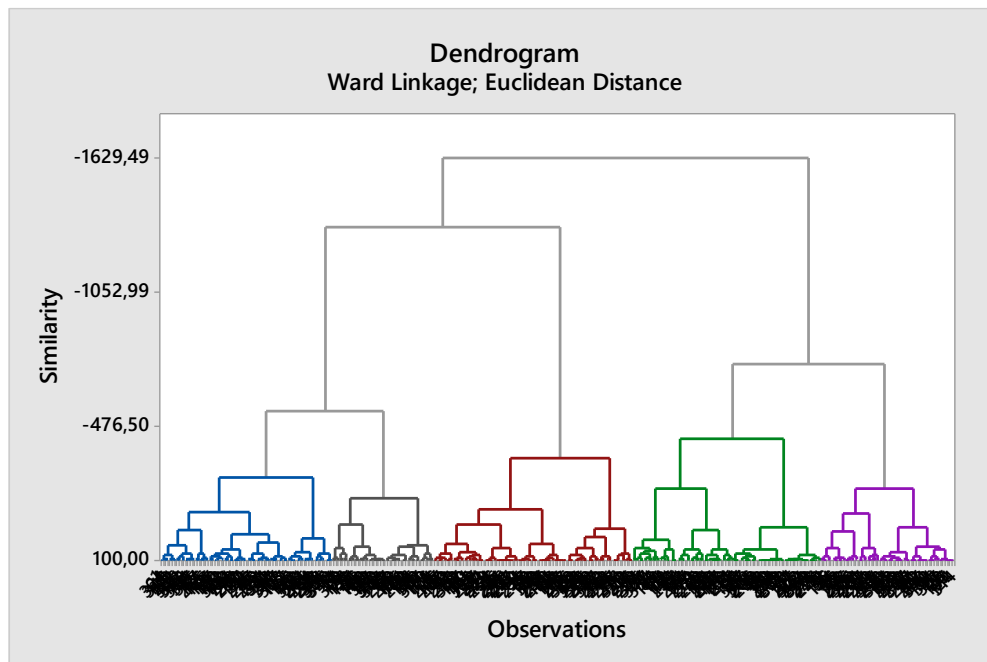
variables representation



Farm representation

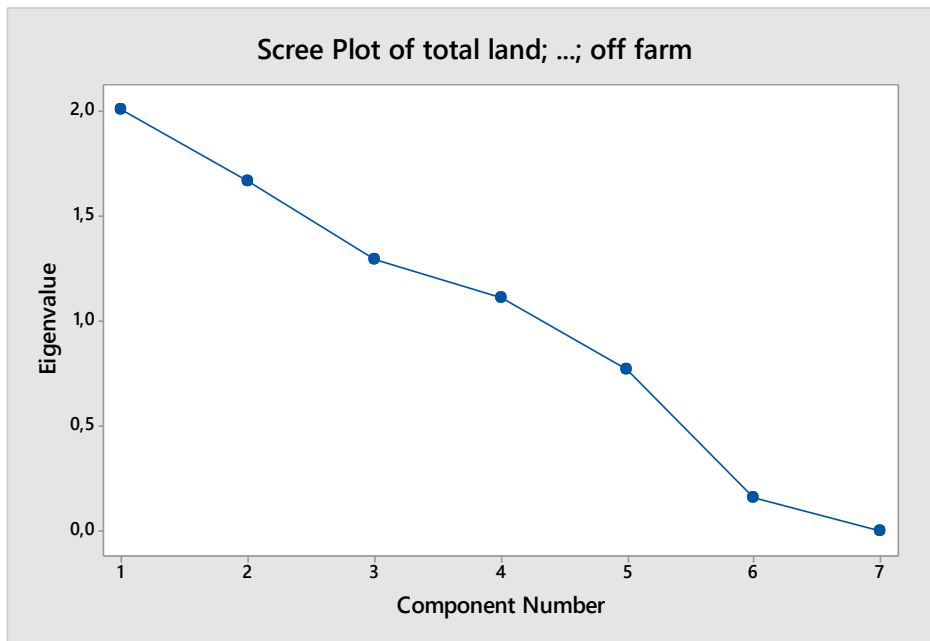


Hierarchical clustering dendrogram

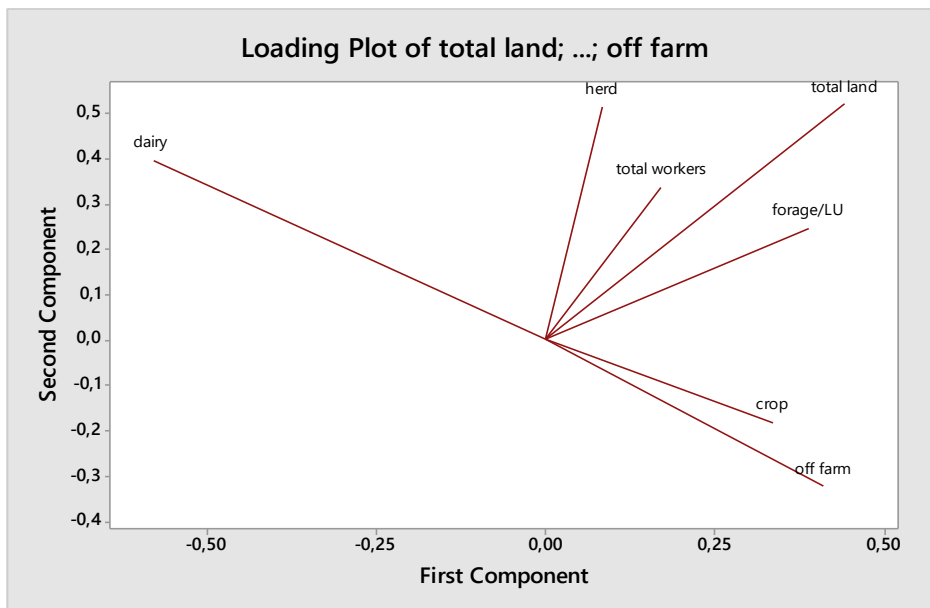


4. Multivariate analysis for type of farm

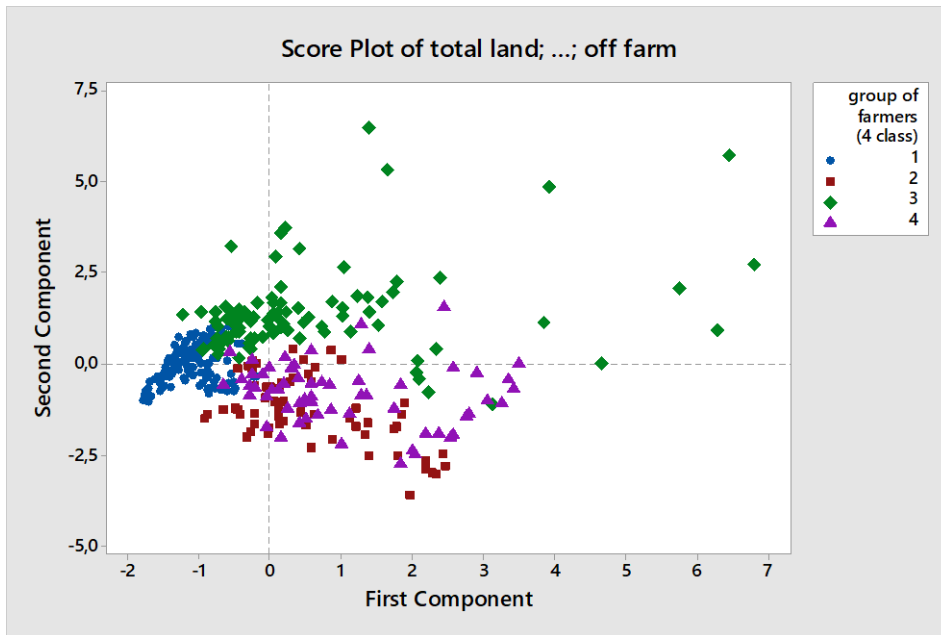
Principal Component Eigenvalue



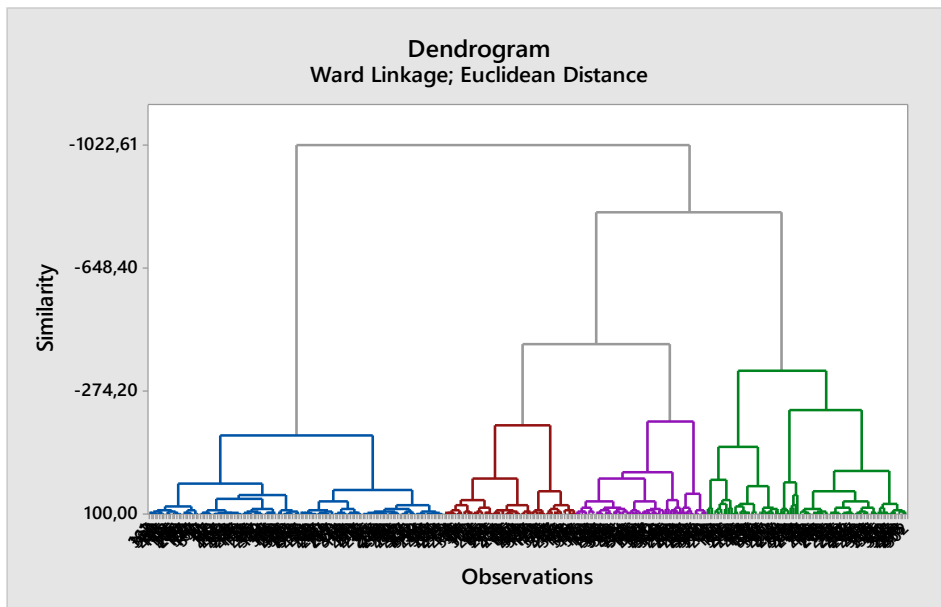
Variables representation



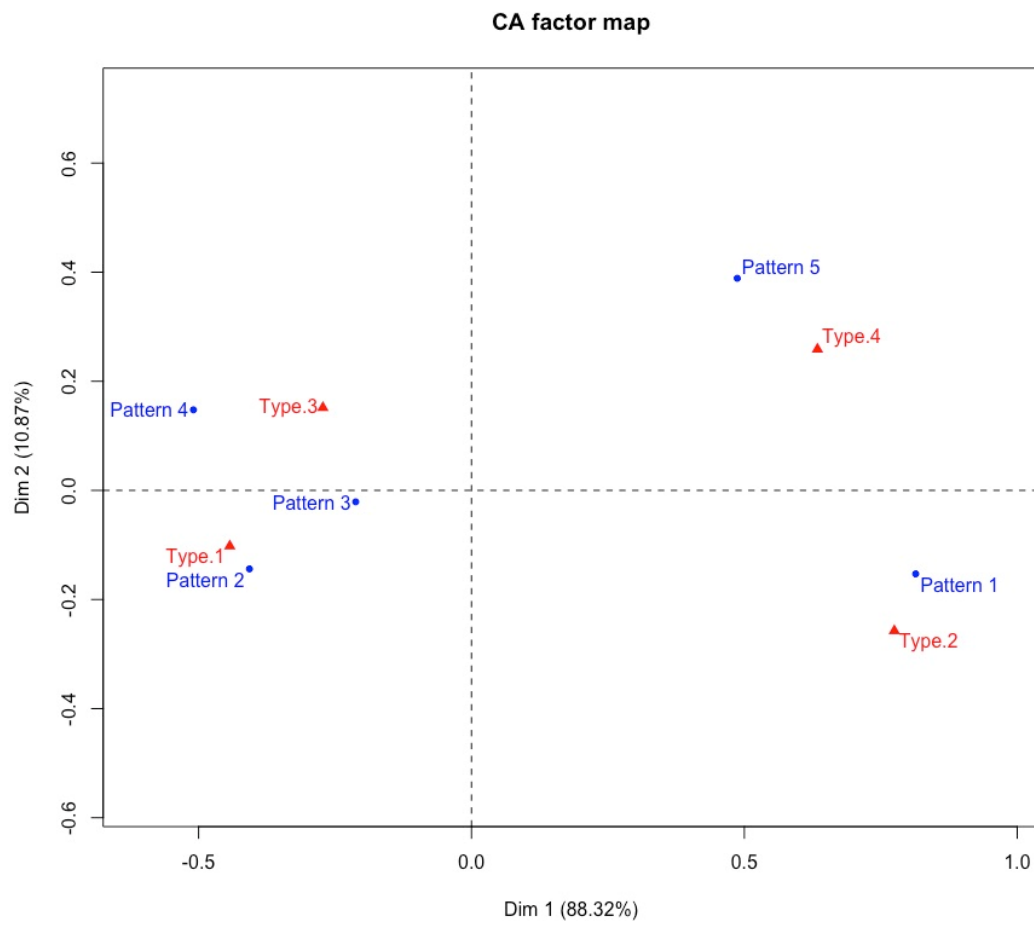
Farm representation



Hierarchical clustering dendrogram



5. Correspondance analysis to make a link between pattern of sustainability and type of farm



6. Indepth interview and monogram for chapter 3

IN038 (Mr Jajang, TPK Nyampai, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Jajang was born in 1981. After graduated from primary school in 1993, he continued and helped his parent's dairy business. Like majority of farmers in Lembang, he raised cow with "shared animal" or in west java we call it "sistem paro". In other words, he took care of cows belonged to another farmer and then the product would be shared with the owner. He received fifteen percent of milk sold and calves borned. Initially, he had one female calf with this system. The calf was raised up to be a lactating cow.

He married in 2000. Before married, he had six cows and one cow have been sold to cover expenses of wedding party. Some calves usually have been sold or changed to heifer. Before became a member of cooperative KPSBU, he was a member of another local cooperative (Sarua Mukti). Since 2008, he decided to be a member of KPSBU. He mentioned that the services and the milk prices from KPSBU were better than other cooperative in this area.

He gave 50 kg of natural grass per cow a day. He had 2100 m² of land and no land rented at the beginning that have been cultivated with napier grass. He also depended on the natural grass that he found in unused land or surrounding area. In addition, quantity of concentrate feed he provided to the cows was more or less 10 kg per cow a day. Concentrate feed he purchased from KPSBU and the payment was directly deducted from milk sold every fifteen days.

Total milk production was 15 liter a day. The net dairy income paid by KPSBU was IDR 2 million a month. Total workers in this farm were two persons included him and his wife.

Recent activity

He has a wife and two children aged 15 years old and 5 years old. Nowadays, his son help him in dairy farming activity after coming home from school. Total workers in this farm are three persons included him, his wife and his son. He has heavier job such as to cut and to carry grass and milking. Meanwhile his wife and his son help him to feed the cows, to clean the barn and to milking.

He has five cows. He provides 120 kg of forage (mostly napier and natural grass) and 30 kg paddy straw for five cows a day. In addition, he gives more or less 3 kg of concentrate mixed with 10 kg of tofu waste per cow a day. In the dry season, he has same feeding management. The feeding time is three times a day.

A total 5000 m² of land used to cultivate napier grass included 2100 m² of owned land and 2900 m² of land rented. He pays IDR 1 million a year for this land.

Peak production is 25 liters of milk per cow a day. All milk are sold to milk cooperative KPSBU. Total net dairy income paid by cooperative is IDR 6 million a month. This amount already deducted with concentrate feed cost. However, he must pay IDR 2 million for tofu waste a month.

All waste are used to make biogas and organic fertilizer. He has an additional income from selling organic fertilizer as much as IDR 120 thousand per two months.

The evolution

Building and the equipment.

Since the beginning, he raised the cows in the same building with his parent's cows. He renovated feed bunks. Previously, feed bunks was high but now it is lower. In addition, drinking system is ad libitum (always available). He explained that he was inspired by extension officer. He was thinking that the cows are more comfort.

He installed biodigester to make biogas.

Feeding management.

Previously, the quantity of forage was higher due to the availability of land. But now, he uses more concentrate. Production of napier grass declined due to the availability of land and workers. Consequently, paddy straw was added to fix this problem.

Since ten years ago, he used tofu waste mixed with feed concentrate. Initially, he only tried and the price of this material was cheap. The milk production was significantly higher than before but if once he did not give it to the cows, the milk production was drastically decreased.

Activity of the production

He focus only on the dairy farming activity. The reason is that he has no land to cultivate other cultivation. The uncertainty price of horticultural product is also become a problem. It depends on the market. In addition, he explained that he is already comfort with dairy farming activity.

Labor

Total workers are increased. His son help him in dairy farming activity. After coming home from school, his son help him to clean the barn, to clean the cows, to feed the cows and to milking. Eventhough, in the future he still does not know if his son will continue dairy farming activity or no.

Land use

Total land use has changed. This farmer add more land to cultivate napier grass. The number of cow increased, so the needs of forage increased. This is the reason why he add more land. It is still not enough to feed the cows, so that is why this farm add paddy straw to cover the needs of forage.

Herd size

Initially, he had only one female calf but after married he already had five cows. In 2011, two cows were dead due to poison from feed. After that, he bought new cow from credit in KPSBU. Until now, the number of cows are five because the capacity of barn for him (he join with his father farm) is only enough for five cows.

Dairy practice

He explained that the knowledge of dairy farming practices has increased. He received some training and extension from KPSBU extension officer. He applied it in his farm such as milking, feeding, and others.

The limitation

To have more cows, the difficulties are capacity in barn and land to cultivate forage.

SECOND INTERVIEW

1. Diversification versus Dairy specialization

Mr Jajang and his family focus on dairy farming activity. He explained that he never thinks to convert his activity. This farmer has good motivation to continue this activity. Income from dairy business can cover daily expenses. In the future, he expected to have house rented so he can have additional and passive income. He mentioned, “dairy business can be an ideal business if at least farmers have six lactating cows”.

Once, we asked about why he is not add other activity generating income such as crop farming. Then he explained that in surrounding area, it is difficult to have land for agriculture. It will need large size of land. If he has it, he mentioned that land will be used to cultivate forage. Since this farmer decide to have only one activity, he can manage dairy farming activity optimally due to sufficient time and worker.

2. Land access

Land access is a constrain in this area. Even so, this farmer has about 2100 m² of land. This land are cultivated with napier grass. In addition, more or less 2900 m² of land rented are cultivated with napier grass. This farmer pay IDR 1 million a year for those land. He explained that it is not easy to rent this land if do not have good relationship with land owner. Once, if they late to pay, the land will be rented to others. Money and relationship are two important things to land access in this area.

3. Forage access

The availability of forage depends on the availability of land. However, farmers can still access forage from outside. For instance, this farmer find natural grass and agricultural by-product to feed the cows. However, availability of natural grass is limited in surrounding area. He also goes to crop farmers to ask agricultural by-product (paddy straw, leaves of vegetables, or others). Those activities to obtain forage are done by family workers only (no hire outside worker).

In case of difficulty to provide forage, this farmer can access it from another farmers. It is not for sale but only for helping each others, he mentioned. Mr Jajang can also access paddy straw from trader. Majority of them come from other district (Subang District).

This farmer prefers to have good balance between forage and concentrate. He explained that it will reduce the productivity and efficiency. If add more concentrate, cost will be higher and income will be lower than usual. In addition, health of cows will be not in a good condition.

4. Waste management

In term of waste management, Mr Jajang process the waste of dairy farm to be biogas and organic fertilizer. He learned those practices from training and extension that have been provided by KPSBU. For biodigester, he was granted by STIKES (higher education of health sciences). His village was chosen as a “biogas village”. The 6 m³ of biodigester was installed between his farm and his brother’s. They use this biodigester together. In addition, part of waste are sold to other crop farmers.

5. The willingness to maintain dairy farming activity, for the new generation

In the future, he will let his children to continue dairy business or no. It depends on passion of his children. He explained that without a passion, it will be difficult to have good business. Eventhough, he realize that dairy business is an interisting business, it

will be nothing if his children does not have passion on this business. So, the best thing is that let them choose based on their will.

Dairy business according to him is interesting, seen from two points: economic point of view and working condition. Dairy farmers in this area receives mid-monthly income paid by KPSBU. In addition, they will have money or even saving from calves and cows. From working condition, farmers will decide to manage correctly their farm or not. They can work freely without intervention from others.

Monogram

	1993	2000	2001	2002	....	2015	2016	2017
1. Activities								
Dairy farming	Part time to help his father in dairy activity	Started dairy bussines (all year in dairy)						
2. Workers								
Husband	Part time							
Son								Part time
Couple		All year in dairy farming						
3. land ownership		Small size for house and barn						
own		2100 m2						
Land rented								2900 m2 from neighbour
4. cultivation								
2100 m2		Napier grass						
2900 m2								Napier grass
5. dairy cattle								
Calves		0	Male calves will be sold and female calves will be replacement stock or sold if needed					0
Heifer		0						0
Cows		5						5

RF004 (Mr Olih, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 1998, Mr Olih started to help his parent in dairy farming activities. After two years, he married and he decided to start his own dairy business. Initially, he had two cows received from his parent. His farm was located on Cigeureung Village, next to dairy farm owned by his parent. Two years later, he moved to Panaruban Village and built new barn for dairy cows. He sold two cows to renovate his house. Recently, one cow was purchased via credit scheme with 0% of interest from milk cooperative (KPSBU). He explained that KPSBU have budget to develop dairy farm in Ciater area.

In the beginning, milk were collected via Mr Ahmad Soleh who was a dairy farmer from this area and then were delivered to KPSBU Lembang. He mentioned that in this area, they had

small number of farmers. So that is why, milk tank from Lembang which has big capacity, was not sent to Ciater because of small quantity of milk in this area.

Number of farmers and KPSBU services in this area increased since they collaborate with private company in 2007. They had collaboration to develop dairy farming activity in this area. Many people started to have dairy farm with three cows through credit scheme. For some people, it was good opportunity to increase livelihood.

This family foccus only on dairy farming activity. Eventhough, sometimes Mr Olih helped his parent in their paddy field. From this additional crop activity (paddy), he received paddy for free from his parent. The agricultural by product (paddy straw) could also be used to feed the cows.

For dairy practices, total number of workers were two persons included his wife and him. Since beginning, he cut and carry natural grass from surrounding area and also he cultivated napier grass at 2800 m² of unused land of PTPN (tea state plantation). With two lactating cows, they produced 35 liters of milk a day. He explained that quantity of forage (mostly napier grass mixed with natural grass) was 40 to 50 kg. In addition, he provided 5 kg of concentrate feed per cow a day which was purchased at KPSBU. He also mentioned that the quality of concentrate was better than at present time.

Recent activity

In the family, there are four persons, including couple, a son, and a daughter. Total activity generating income is only dairy farming activity. Eventhough he helps his father in crop farming (paddy), but he only receives paddy for family consumption every harvest time (twice a year). Nowadays, not only a couple who work in dairy activity, but also their son after come home from school.

They have two lactating cows, and a heifer. In addition, they also raise a male calf belong to his parent. Total 2800 m² of land access are cultivated with napier grass at PTPN. This farmer also need natural grass from surrounding area to feed the cows. Quantity of forage is more or less 40 kg per cow a day which is mostly napier grass mixed with napier grass and paddy straw. They provides 5 kg of concentrate and 8 kg of casava waste as a ration for cows.

Milk produced is 25 liters from two lactating cows. As a member of milk cooperative (KPSBU), all milk are delivered to this cooperative. As a consequence, this farmer receive many services such as credit, animal health services, daily needs, and others. Total income from milk selling is about IDR 2-3 million a month.

The evolution

Building and the equipment.

In the beginning, they kept the cows in the barn next to their father farm which located a bit far from their house. However, two years later, they moved and built a new barn close to their house. In 2014, they received renovated feed bunk and drink system helped by Dairy Development Project in this area.

Feeding management.

The quantity of forage and concentrate has changed. He explained that natural grass were easy to find because of number of dairy farmers were not too many, but now dairy farmers increased and they have high competition to find natural grass. As consequence, this farmer mixed paddy

straw in the ration. If they compare, ration for forage was higher than in present time. Nowadays, they use much more concentrate and cassava waste.

Activity of the production

Since the beginning, they only focused on the dairy farming activity. The main reason is that they have limited or almost no time for another activity. It will take more time and energy if they add more activity.

Labor

Since their son were grow up, he can help on dairy farming activities after coming home from school. Their son will to continue their dairy business so that is why he decided to continue his study at vocational high school focuss on animal husbandry.

Land use

There is no change about land use since they started dairy farming activities in 2000. They still depend on land from PTPN to cultivate napier grass. However, they still need to buy additional forage such as paddy straw to secure cows needs. In addition to that, they have to find natural grass from surrounding area. He explained that nowadays he is difficult to find natural grass because the number of farmers increased and they have to compete with others to cut and carry it.

Herd size

Initially, they had two lactating cows received from parents. They gradually had more cattle year by year. He had sold two cows to renovate their house. He received one cow assisted from Livestock Services of Subang District two years ago. In the last year, he added one more cow via credit from KPSBU with 0% of interest because KSPBU collaborate with private company has budget to develop dairy farms in this area.

The limitation

The limitation is about time and energy to cut and carry the forage (napier or natural grass). Eventhough, they cultivate napier grass at PTPN land, the distance is far from barn. It takes time to cut and carry it. In addition, the availability of natural grass is limited. If they plan to add more cows, they have no money because they have to pay credit for previous cow from KPSBU.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Since started dairy farming activities, Mr Olih focus on dairy business. However, he sometimes helps his parent on crop farming (paddy) activity. He is never paid by his parent but from this activity he receives paddy for free when harvest time. In addition, he can also access agriculture by-product (paddy straw) to feed the cows. He mentioned that paddy straw could be given directly to the cows or could be processed as silage. On the border of paddy land, he also cultivate napier grass.

Actually, by doing this additional activity, no negative things happen on his dairy business. It is because he can well manage his time when to go to paddy land and when to do dairy farming activities. Activity on crop farming does not take a lot of time. After, he finish to cut and to carry grass, he can help his parent on paddy activity. Until now, both activities are well managed.

Crop farming activity can help dairy business particularly to provide forage feed for dairy cows. Paddy straw and napier grass planted on border area of paddy land can be used to feed the cows. However, dairy farming activity do not give any feed back to crop farming activity. It is because manure from dairy cattle are directly processed to be biogas. The residual from biodegester are evacuated to surrounding area. Eventhough, he received training on waste management to process residu from biogas to be organic fertilizer. It is because the distance between paddy land or land to cultivate forage and the farm is relatively far, so he is difficult to bring it to those land. As consequence, cost of organic fertilizers need to be added on those land.

2. Land access

Mr Olih access 2800 m² of land at PTPN to be cultivated with napier grass. At the moment, land access at PTPN is enough to feed the cows. Every farmers in this area actually can access those land that is not planted with tea. However, it depends on willingness and effort of farmers because the location of those land are relatively away from farm. In addition, Mr Olih menioned that he can add natural grass and paddy straw to feed the cows.

If he has income or capital, it is better to rent land that near from the farm. It can save his time to work efficiently.

3. Forage access

Beside napier grass at PTPN, Mr Olih also cultivate this grass on the border of paddy land. He can also access natural grass but the distance is far from farm. Paddy straw as mentioned, can be added to feed the cows.

The availability of natural grass is relatively high particularly during rainy season but the location is far from farm. He explained that couple years ago, he can find natural grass which is not far from farm but now because of the increasing number of dairy farmers, the availability of natural grass in surrounding area is limited.

In case of emergency, he can purchase grass from other farmers. He prefers to do that than hire worker to cut and to carry grass because it is more simple. If he want to buy natural grass, he can buy it to the trader or other farmers. The price is IDR 10 thousands per bundle. He needs two bundles a day. He also explained that it is not difficult to buy grass from outside eventhough not so many. For paddy straw, Mr Olih depend only on paddy land of his parent, so that he does not need to buy from outside.

Mr Olih explained that if he has limited forage, alternatively he add quantity of cassava waste and concentrate. According to him, those additional feed can cover the needs of cattle. It can increase milk production but feed cost will be increased.

4. Waste management

This farmer uses biogas to manage waste from farm. He installed biogas since couple years ago. Initially, KPSBU offered this biogas through credit scheme for five years. At that time, KPSBU had collaboration with NGO to provide biogas. This program gave positive impact to the farmers. Farmers can reduce cost of gas for cooking, or even they do not need buy gas anymore. This biogas is also useful to boil water to cleaning udder of cows before milking.

Residual from biodigester are directly evacuated to waterways. He mentioned that once he evacuated those waste on land planted by tea, however the tea plantation did not grow well. It might be over dosage.

Every farmers actually can access this credit to install biogas. The reimbursment is only IDR 100 thousands a month. However, some farmers have no space available in barn to install it. Therefore, until now not every farmers have it. Consequently, those farmers evacuate the waste to waterways which might lead to the environmental problem.

5. The willingness to maintain dairy farming activity, for the new generation

Currently, his son is in vocational school of livestock. It shows that his son is interisted in this sector. Mr Olih explained that his son has a freedom to decide wheter to continue on his family business or not. However, he expected that if the number of cows increased, he wants his son to continue dairy farming activity.

Dairy business is still interesting. He explained that he feel comfortable, free, and no one ask him as a wage worker. The success of this activity will depend on how farmers manage it. Income from milk selling will be received every fifteen days and additional income will be obtained if he sells calves or cows.

Monogram

	1998	2000	2012	2013	2014	2015	2016	2017
1. Activities								
dairy farming	Help father on dairy business	Started own dairy business						
2. Workers								
Husband	Part time to help his father dairy farmer	All year in dairy farming						
Son						Part time as dairy farmer after coming from school		
3. land ownership								
Land access		2800 m2 at PTPN + small size on border of his father's paddy land						
4. cultivation								
2800 m2		Napier grass						
5. dairy cattle								
Calves		0	He select good female calves to be replacement stock but sometimes are sold if needed. Usually, for male calves are sold					0
Heifer		0						1
Cows		2	Sold two cows to renovate house			Received one cow from livestock services	Add one cow from credit KPSBU	2
Bulls		0						0

RF055 (Mr Dadang, TPK Pasar Kemis, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Dadang already helped his parent in dairy farming activity since he was in primary school. He married in 2009, then in that year he started his own dairy bussines. He explained that he already had experience on dairy farming and there was no other activity generating income. In the beginning, he received one lactating cow from his father. He raised up and kept the female calves to be lactating cows and sold the male calves after three to four months old. Until present, he only foccus on dairy farming activity. He worked together with his wife. His wife helped him to clean the barn, to feed the cows, and to clean the cows.

The total 7000 m² of land given by his father have been cultivated with napier grass or king grass. In addition, total 4200 m² of land rented from collaboration between milk cooperative (KPSBU) and PERHUTANI. Every fifteen days, the payment of milk sold to cooperative was directly deducted with this cost.

The quantity of forage to feed cows was more or less 50-60 kg of grass. In the dry season, he mixed napier grass with small amount of paddy straw. Mr Dadang also provided 3-5 kg of concentrate which was purchased from KPSBU, 10-11 kg of tofu waste and 10-11 kg of cassava waste.

Total milk production was more or less 15 liters per cow a day. Peak production of milk was 23 liters per cow a day. As a member of cooperative, all milk sold to KPSBU. Total income from cooperative was around IDR 1 million per fifteen days. Milk price was IDR 2000 per liter.

Recent activity

He has a wife and a child. Since the beginning, he only foccus on the dairy farming activity. Until now he works together with his wife on this activity. This family has three lactating cows and one female calf. He mentioned that a calf will be raised up to be lactating cow.

Total land used is around 1,1 hectare included 7000 m² of owned land and 4200 m² of land rented from PERHUTANI. All land are cultivated with napier and king grass. He provides 180 kg of napier grass for three cows a day. In the dry season, usually he add paddy straw as a complementary fodder. In addition, the quantity of concentrate given to the cows is around 150 kg per three cows per fifteen days. Feed concentrate is purchased from KPSBU and the price is IDR 3000 per kg. He also mixes concentrate with 500 kg of tofu waste and 500 kg of cassava waste per three cows per fifteen days. Concentrate, cassava waste, tofu waste and water are mixed together then it will be given to the cows three times a day.

Milk production a day is 42 liter from three lactating cows. According to him, the milk production is relatively decreased because in the past he had good cow genetically. However, he sold this cow because it was already old. The monthly income from milk sold to cooperative after deducted with concentrate cost and land rented cost is more or less IDR 3 million.

Waste from this farm are sold to others. Usually, person uses this waste as organic fertilizer.

The evolution

Building and the equipment.

In 2012, he renovated the barn. Previously, floor of barn is made from soil or wood but now he uses concrete for the floor. It is important for the cow's comfortability. He sold one calf to this renovation. However, the capacity of barn is only enough for four cows.

Feeding management.

Since beginning, there is no change regarding feeding management. He mentioned that forage feed is still enough until now even though increasing the number of cow.

Activity of the production

He focus only on the dairy farming activity since beginning until present. Some reasons are he has no available time to add more activities generating income. In addition, he explained that the income from dairy farming activity is enough to cover daily expenses. He also already experienced on dairy farming activity since along time.

Labor

This farm has no change in term of labor. The couple works together since started own dairy bussiness.

Land use

Total land used is relatively bigger than others. He explained that with this size, the forage produced is enough to feed all cows. So, he does not need add more land to cultivate forage.

Herd size

Initially, he had only one lactating cow but nowadays he has three lactating cows and one calf. He does not plan to add more cows because the capacity of barn is only adequate for four cows.

The limitation

To have more cows, the difficulties are capacity in barn and worker.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Dadang is one of farmer who only focus on dairy business since beginning. This activity according to him is a good activity because he can cover daily expenses and can buy their needs from this business. He explained two reasons why he focus on this business. First, he spend all time and energy to manage dairy cows so that the result will be optimal. If he add another activity, time and energy will be limited and it might affect his family income. Second, this farmer has no land available to have another activity.

He mentioned that to have ideal income from dairy business, at least farmers must have five lactating cows. It will be matched with capacity of farmer's to manage dairy farm (time, energy, worker, land, and others). Stable income (relatively) from this business will be received from milk selling paid by milk cooperative (KPSBU).

2. *Land access*

Land access is not a constrain for farmers in surrounding area. He can access land of PERHUTANI to be cultivated with napier grass. This farmer has relatively big size of land access compared with other farmers. Total 1,1 hectares of land access including 0,7 hectares from PERHUTANI and 0,4 hectares owned, are cultivated with napier grass.

At the beginning, he proposed to KPSBU about land access at PERHUTANI, and his proposition was accepted. He was informed by other farmers about this land. Every fifteen days, he must pay to KPSBU for those land. It will be deducted directly from

milk selling. According to him, there is no written contract between farmers with KPSBU or PERHUTANI about the duration to access those land. Some farmers in this area cannot access those land but he did not know why. According to extension officer of KPSBU, it might be related to the ability to pay and the availability of land.

3. *Forage access*

Farmers can also access natural grass from surrounding area. He mentioned that sometimes he find natural grass from surrounding area or other district. In the rainy season, it is easier to find this grass than in the dry season. Eventhough, farmers have to compete each others, the needs of forage feed is still enough for his farm. This farmer does not need to hire worker from outside because he can manage all by himself and his family.

In this area, very few farmers who sell fodder because actually they also need it. Farmers in this area have good relationship each others. It can be seen when one farmer needs grass to feed the cows but he has problem about it, another farmer will come to help. It is only for a case of emergency.

If Mr Dadang difficult to provide forage to the cows, he does not add more concentrate. According to him, it is not good for a balance between forage and concentrate. It might cause cows in a bad condition (not healthy).

4. *Waste management*

Mr Dadang process waste from farm to be organic fertilizer. Part of waste are directy transported to crop field and some others will be dried and then sold to crop farmers. Unfortunately, other part of waste are evacuated to the waterways. It might cause problem of environment. He explained that why he does not install biodigester. Actually, he knew already the useful of biogas and KPSBU also provides credit scheme with only pay IDR 100 thousands a month to install biogas. However, he does not have available space in barn to install it.

5. *The willingness to maintain dairy farming activity, for the new generation*

Dairy business is a good business. He explained that dairy farmers are free men and independent. They manage their business without any intervention. The income from milk selling and calves selling are also interisting. However, he does not want let his children to continue this business. He mentioned that this activity is very tiring. It takes a lot of time and energy. Hiring worker might be a solution if they want to continue this family business.

Monogram

	1994	2008	2009	2010	....	2015	2016	2017
1. Activities								
Dairy farming	Part time to help his father in dairy activity	Started dairy bussines (all year in dairy)						
2. Workers								
husband	Part time							
Couple		All year in dairy farming						
3. land ownership		Small size for house and barn						

Land owned		7000 m2 from parents					
Land rented		4200 m2 in the forest (from PERHUTANI)					
4. cultivation							
11200 m2		Napier grass					
5. dairy cattle							
Calves		0	Male calves will be sold and female calves will be replacement stock or sold if needed				1
Heifer		0		1			0
Cows		1		0			3

RF018(Mr Waryana/Mrs Komala Dewi, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mrs Komala Dewi and Mr Waryana started dairy farming activity since four years ago. Mostly, Mr Waryana worked a lot in the farm meanwhile Mrs Komala Dewi only helped him sometimes to clean the barn and to feed the cows. Previously, she worked as trader of souvenir, cigarettes, candy and others at tourism area. Meanwhile, her husband worked as a wage worker (house construction). They decided to convert activity generating income because the income from dairy business was more profitable than two other activities. She explained that when she was a trader, the income was unstable and uncertain. In addition, she mentioned that it was time consuming and energy consuming because every day, she had to go to tourism area even in rainy condition.

To start dairy activity, initially he bought a heifer which price was IDR 8,6 million. Unfortunately, after three times calving, this cow was already paralyzed. Every calves borned would be kept in the barn, or sometimes have been sold or changed to heifer or lactating cows. Since six months ago, he bought a new pregnant heifer which price ws IDR 14 million.

This farm had 1000 m2 of land to cultivate napier grass, banana and cassava. In the rainy season, cassava would be consumed by family but in the dry season, cows would eat cassava and banana trunks as additional feed. Since three years ago, he had 2000 m2 of land access at PTPN (state tea plantation) to cultivate napier grass.

Quantity of forage given to the cows was 40 kg per cow a day. In addition, they provided 4,5 to 5 kg of concentrate feed purchased at KPSBU per cow a day. Sometimes, when he had limitation to provide concentrate, they added small amount of cassava waste as ration.

Peak milk production was only 12 to 13 liters per cow a day. All milk were delivered to KPSBU. The income from milk selling every fifteen days was only IDR 125 thousands. She explained that this farm had no experience of dairy farming practices so the milk production and the income were low.

Recent activity

The member of family is five persons including the couple and three children (15 years old, 6 years old and 2 years old). Mr Waryana mostly works alone in the farm and his wife focuses on take care of the children. However, sometimes she helps him to feed the cows and to clean the barn.

This farm has a pregnant heifer, a lactating cow, a female calf and a male calf. A male calf will be sold at Idul Adha (Holiday for muslims) because the price will be high. They plan to buy a new lactating cow at that time.

They do not change feed management. Quantity of forage which mostly napier grass given to the cows is still 40 kg per cow a day. If needed, they also add natural grass. In addition, they provided 4,5 to 5 kg of concentrate feed purchased at KPSBU per cow a day. They sometimes add small amount of cassava waste as ration. Cassava and banana trunks will be added in the dry season due to the availability of forage.

Total land access is 3000 m² including 1000 m² of owned land and 2000 m² of land from PTPN. More than 2000 m² of land are cultivated with napier grass.

Milk production nowadays is 18 liters per cow a day. The cow produces high yield because three days ago the cow was calving. All milk are delivered to KPSBU. The income from milk selling is more or less IDR 800 thousands per month.

This farm received assistance from KPSBU to install biodigester. Manure from this farm and two other farms surrounding area will go to digester and they can use biogas from this installation. It is very useful to manage waste of farms.

The evolution

Building and the equipment

Since dairy development project in Ciater area, building was renovated. Feed bunk and drinking system have been changed. Feed bunk is lower than before and also was made with ceramics. Drinking system are now refilled automatically.

Feeding management

Feeding management is relatively similar with before. However, particularly in the dry season, they add banana trunk to complement napier grass and natural grass. Availability of water is now better because they have ad libitum system.

Activity of the production

Dairy business is main business until now. Eventhough, some part of land they cultivate banana and cassava, those are mostly for family consumption. If they have more, those are given to the cows. This farmer add another activity generating income (work as wage worker) only when the cows are in the dry period (not producing milk).

Labor

Since beginning, a couple work together on dairy farming activity. A wife only help on some activities such as cleaning barn, cleaning animal, and feeding animal. Meanwhile, a husband conduct heavier activities such as milking cows, cutting and carrying forage and others.

Land use

Land use increased since three years ago. Initially, they only depended on their land to cultivate forage but now they can access land of PTPN. Those land are unused land and relatively far from farm. It takes time to go there.

Herd size

Started with only a heifer, nowadays this family has one pregnant heifer, one lactating cow, and two calves. Every female calves borned, will be selected to be replacement stock. Male calves usually are kept until Idul Adha (Holiday for Muslims) and then will be sold in order to have better price.

The limitation

Main limitation is money to add more cows. With this number of cows, calves borned sometimes are sold to cover daily expenses. Income from milk selling, sometimes is not enough.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Waryana and his wife (Mrs Komala Dewi) focus on dairy business. Previously, they worked as trader and wage worker. Mr Waryana will be a wage worker (to build house or others) if all cows in the dry period (no cows are producing milk). It is needed because their family need income to cover daily expenses. It does not take a lot of time and he can manage it. It is because in the dry period, some activities such as milking, cleaning animal, cutting and carrying grass will be reduced. So, they have more time to have other activity. All cows are still well managed.

Actually, they also have land that is not only cultivated with napier grass but also cassava and banana. Those plants are usually for family consumption but if they have more at harvest time, they will sell part of them. Eventhough, not really as an activity generating income, cultivate banana and cassava can have synergy with dairy farming practices. For instance, fertilizers are provided from waste of dairy farm, cassava and banana trunk can be used as feed for cows. Needs of feed will be helped by adding those plantation. It does not take time because they only let those plants to grow and can harvest it after few months later.

2. *Land access*

Farmers in Ciater area can access land from PTPN. However, it depends on willingness and time. In addition, farmers are not allowed to disturb productive land which are planted by tea or other plantation. Consequently, farmers have to find unproductive land which far from farm and will take more time. Total land access is more or less 3000 m² including 1000 m² of owned land and 2000 m² of land from PTPN. More than 2000 m² of land are cultivated with napier grass. Some others are cultivated with banana and cassava.

3. *Forage access*

This farmer provide not only napier grass but also natural grass. In the dry season particularly, they also add cassava and banana trunks. They mentioned that availability of natural grass is still enough to feed their cows because at the moment they only have one lactating cow and two calves. Natural grass can be found in surrounding area. They do not need hire outside worker because Mr Waryana can be enough to cut and to carry grass. In case of emergency (lack of forage), they do not purchase grass, they will add more concentrate. Quantity of milk production will be stable or even higher. They mentioned that there is no effect to the cows.

4. *Waste management*

Waste of this farm is well managed. Part of waste are processed to be biogas and part others are evacuated to land for forage, banana and cassava. Mrs Komala Sari (wife of Mr Waryana), explained that one biodigester is installed for three farmers surrounding area. She forgot, it was provided by KPSBU or by Livestock Services. However, she does not need to pay. Those three farmers can use this biodigester to process biogas and this biogas is used for cooking. According to her, every farmers in this are will receive this biodigester. They only need to wait their turn.

5. The willingness to maintain dairy farming activity, for the new generation

This farmer mentioned that dairy business is a good business. Income from milk selling and calves selling are interesting. Cows can become asset and saving. However, if only have small number of cows, it will be a bit difficult to cover daily expenses. Consequently, they add more activity in some situation such as cows in the dry period.

Even so, they mentioned that they want their children to have another activity generating income for instance government employee. Income from government employee is more stable and guaranteed. Every month, they will receive money. In addition, they will also have income of pension after retired.

Monogram

	2012	2013	2014	2015
1. Activities				
Dairy business	Started with only a heifer			
Wage worker	Part time (Only if cows in the dry period)			
2. Workers				
Couple	All time			
Husband	Part time as wage worker			
3. land ownership (date of acquisition)				
Land owned	1000 m2			
Land access		2000 m2 Access to PTPN		
4. cultivation				
700 m2	Napier grass			
300 m2	Banana and cassava			
2000 m2		Napier grass		
5. dairy cattle				
calves	Male calves will be sold and female calves will be replacement stock			2
heifer	1			1
cows	0			2

IN047 (Mr Uun/Mr Duki bin Ita, TPK Bukanegara, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 2013, Mr Uun, a grand son of Mr Duki bin Ita started dairy farming activity. As a member of milk cooperative KPSBU, he was registered by using his grand father's name. After married, he helped his grandfather bussiness in the market for five months. They sold vegetable in the market that they bought from farmers. Then, he stopped this activity after he had one lactating cow.

In the beginning, he bought two calves and he raised up to be two heifers. He then changed two heifers plus money with two lactating cows. One lactating cow was pregnant and another one was not. Every female calves borned, he kept it to replace the old one. Usually, he sold male calves after four to eight months old.

To feed the cows, he was helped by his father for a few times. Then after he had lactating cows, he was able to provide feed to the animal. The quantity of napier and natural grass was more or less 50 to 70 kg per two cows. Total of 1120 m² land rented have been cultivated with napier grass. He worked together with his parent on this land.

The quantity of milk produced was more or less 15 liters per cow a day. The maximum milk production reached 20 liters per cow a day. All milk directly sold to cooperative every morning and afternoon. He received money every fifteen days from KPSBU after deducted with concentrate cost. The monthly income from KPSBU was IDR 1,8 to 3 million.

Recent activity

He has a wife and a daughter aged three years old. But only him who works in dairy farming. His wife focusses on taking care of their child. Nowadays, he has one lactating cow, one cow in dry period and two heifers.

Total 1120 m² of land rented, he uses together with his parent to cultivate napier grass. He pays IDR 400 thousands for this land a year. He provides more or less 70 kg of napier grass mixed with natural grass per four cows a day. He also gives 5 kg per cow a day of concentrate feed purchased at KPSBU and 8 to 9 kg per cow a day of cassava waste purchased from traders. The milk production per cow a day is 16 liters. This farm (like other farmers surrounding area) has two times milking, in the morning and in the afternoon. After milking, he delivered milk to TPS (milk collecting point) that only 10 to 20 meters away from the barn. This TPS is one of the best milk collecting point from all KPSBU area. Sometimes, the farmers in this TPS receive a highest price of milk from cooperative. In KPSBU, the milk price depends on the quality of milk in each TPS. They have quality test regularly.

Currently, the monthly income paid by milk cooperative for this farm is around IDR 1,4 million. He has lower income at that time because only one cow can produce milk. Meanwhile, feed cost is higher due to the increase of number of cow.

The evolution

Building and the equipment.

There is no change in the building. The capacity is only enough for four cows.

Feeding management.

In the beginning, when the number of cows was two cows, he mentioned that the quantity of forage was enough. However, nowadays the quantity of forage is significantly lower. The reason is that the ability of land rented, worker, time and energy to produce grass is similar with previous condition, but the number of cows are doubled. Consequently, he provides small amount of forage. He has no idea but to add more concentrate or cassava waste.

Activity of the production

He focus only on dairy farming since he had two lactating cows. Previously, he helped his grandfather in the market to sell the vegetable. He decided to dairy business because he was inspired by his parent to be dairy farmer. He also explained that dairy farming might be not as

difficult as other activities. He has physical capital such as cow and other from this activity so that he can easily access credit for daily expenses and others.

Labor

There is no change regarding the labor. Since the beginning, he works alone on his farm. His wife focuses on taking care of his daughter. Until now, he can handle all the activities on dairy farming by himself.

Land use

Since the beginning, small size of land rented to be cultivated with napier grass. He uses this land together with his father as a source of grass for their cattle. Until now, he does not use more land for this activity.

Herd size

Initially, this farmer only had two calves. Then, he raised up and kept the female calf so he had more cows until now. He explained that his ability is only enough for four cows. He does not plan to add more cows than four. He plans to sell the cows if more than four.

The limitation

They find it difficult to add more cows due to the availability of land to produce grass. If they depend on the natural grass, it will take more time and energy. In addition, sometimes they need money from selling calves.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Nowadays, Mr Uun focuses only on dairy business since 2014. He explained that if he has another activity generating income, he won't have enough time to manage dairy farm. As a consequence, his dairy business will not be well managed. For financial situation, dairy business can cover daily expenses but it depends on the status of cows. In other words, if the cows are in the dry period (no produce milk), it is a difficult situation. However, he can face it after the calves are borned.

He explained that sometimes if he only depends on milk selling, it might be difficult because it could not cover all daily expenses. So the strategy is that every female calves borned, will be raised up until pregnant heifer. After that, he will sell it. The fifty percent of income from this selling will be saved and the rest will cover all daily expenses.

He also told that previously he had trading (vegetables and fruits) activity with his grandfather in the market. Even, he also continued his study at university during this period. Then, he decided to be dairy farmer because trading activity provides unstable income. It really depends on the market price. However, dairy business offers not only stable income (every fifteen days, he receives milk payment from cooperative) but also saving from milk selling or calves selling. If he adds other activity for instance crop farming, it is also difficult due to limitation of land access.

2. *Land access*

Like other farmers in surrounding area (Lembang), land access is a main constraint. He has 1120 m² of land owned by his grandfather and he cultivates napier grass together with his parent. Even though, he has enough money to rent land, land available is

difficult to find. Farmers must have good relationship with landowner. In this area, demand of land for forage is very high. Every farmers must compete to obtain it.

3. *Forage access*

Beside napier grass at family land, Mr Uun also needs natural grass to cover the animal needs. Until now, he find natural grass not only in surrounding area but also in the area where far from farm. Motorcycle is used to bring those grass. In the dry season, this farmer must look for grass in Subang District. He explained that nowadays availability of grass is limited. Increased number of farmers in this area are resulting high competition to get forage.

At the moment, he does not need hired worker to help him on cutting and carrying grass. It is because he can cover it by himself. In case of emergency, some farmers in the area can help him to provide forage. Sense of brotherhood between farmers are relatively good. This farmer usually prepare grass for 15 days, but if quantity of forage is limited, he prefers to find forage even in Subang District. He does not want to add more concentrate or cassava waste. He explained that the reason is not only cost of feed will be increased but also performance of animal health will be decreased.

4. *Waste management*

Until now, mostly waste of farm are evacuated directly to the waterways. He mentioned that some neighbours protest about this waste due to problem of smell. However, since government installed bigger waterways, there are no more who protest. Small part of waste (dried waste) are processed to be organic fertilizer. He provides waste pit to collect manure. Other farmers (crop farmers or others) can access this waste for free.

Like other farmers, actually Mr Uun also can easily access credit from KPSBU to install biogas. However, the problem is that distance from farm to the house is a bit far. He explained that if he install biogas, it will be not efficient so that he decided to avoid this practices.

5. *The willingness to maintain dairy farming activity, for the new generation*

Dairy business according to him is a good business. Not only income from milk selling but also from cows and calves selling will be received from this business. He shared his story, at the beginning he only had two calves but now there are two cows and two heifers. The assets will steadily increase. Other farmers are inspiring him to be a success dairy farmer. If they can do it, so he can too. To be optimum in this business, he mentioned that three lactating cows and two calves will be efficient based on his capacity to manage it.

His daughter has a freedom to continue this family business or no. It depends on her desire. However, he expected that it is better to continue study until university and will work to the office.

Monogram

	2013	2014	2015	2016	2017
1. Activities					
Trading	All year to help his grandfather	Stop activity			
Dairy farming	All year in dairy farming (started with two calves)				
2. Workers					

Husband	All year in dairy farming and vegetable trading	Focus on dairy farming all year			
3. land ownership	Small size for barn and house				
Land rented	1120 m2 (together with his parents)				
4. cultivation					
1120 m2	Napier grass				
5. dairy cattle					
Calves	2	Male calves will be sold and female calves will replace the old one			
Heifer		2 (barter with two lactating cows)			2
Cows		2			2

IN040 (Mr Nandang bin E Kosasih, TPK Citespong, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Nandang has started his dairy business since 1990's. Initially, he bought two heifers and raised them up. Female calves borned were kept to be replacement stock but sometimes were sold if needed. Every male calves were sold at three months old. He hired outside family worker to help him in this dairy business. However, since 2000, the worker of this dairy business was his son-in-law. The 50 percent of income from this business are shared to his son. Beside dairy farming activity, he also had another activity generating income, such as trading of tofu waste. His second son who runned this business. The income is also shared together (50:50).

To feed the cows, he depended on natural grass, banana trunk or sometimes purchased napier grass from others. He did not have owned land to be cultivated with napier grass. In addition, he had difficulty to rent land due to the availability of money and land. He still found natural grass from surrounding area. Sometimes, he find paddy straw from other area (Subang Distric). However, the distance is far from barn so it takes time and cost. Since five years ago particularly in dry season, he used paddy straw to feed the cows from trader who send it directly to his farm.

He provided 40 kg of natural grass per two cows a day. In addition, cassava waste and tofu waste were given to the animals.

Recent activity

In the family, he has two children including boy and girl. Both are already married. They live in the different house but in same location (next to his house). His children help him on activities generating income including dairy farming activity and trading. The income will be shared together. Nowadays, this family has two lactating cows, one heifer, two pregnant heifer, two male calves, and one female calf.

Until now, Mr Nandang only has small land for house and barn. He does not have land to cultivate forage. Therefore, he has to find natural grass from surrounding or even other area (Subang District). In the dry season, this farmer buy paddy straw from Subang District. He explained that milk production will be different if using paddy straw and natural grass or napier grass. Paddy straw can reduce milk production until 3-5 liters per cow a day.

Quantity of natural grass given to cows is about 20-25 kg per cow a day. In the dry season, 10-12 kg of paddy straw is added to be mixed with natural grass. Total 4-5 kg of concentrate mixed with 12 kg of tofu waste and 6 kg of cassava waste are provided to a cow a day. Concentrate feed is purchased from KPSBU (milk cooperative). He received sometimes subsidy from government for this concentrate (150 kg in a few years ago).

Milk production is 15 liters per lactating cow a day. Milk production if he uses paddy straw to feed cows is only 10-12 liters per cow a day. The monthly income from milk selling is about IDR 3-4 million. It will be shared 50% for his son-in-law. In addition, net income from trading is about IDR 3 million.

The evolution

Building and the equipment

Barn and equipment are relatively similar with before. This farmer is not the one who receive renovated barn from the dairy development project.

Technology

There is no change. No new technologies are applied at this farm. Biogas is not applied yet due to limitation of land. No milking machine and no feed processing technology are adapted.

Feeding management.

Natural grass have been mixed with paddy straw. Eventhough, the milk production decrease, no other option to face the limitation of forage. Sometimes, napier grass can be purchased but no available all the time. Farmer should compete with other farmers to get this grass.

Activity of the production

Two activities have been done since couple years ago including dairy farming activity and trading of tofu waste. Both activities are still complementary each other and resulting better income.

Labor

Initially, an outside family worker was hired but since his daughter was married, the husband of his daughter (Mr Dedi) replaced this worker. Since the beginning, Mr Nandang only managed the farm but technically he was helped by worker.

Land use

Since beginning, the main problem is land access. He had no land and he difficult to rent it. The solution is to find forage (natural grass and paddy straw) from surrounding area or he also can purchase napier grass from others. They have to compete with other farmers.

Herd size

The population increased year by year but sometimes they have to sell it if needed. Now he has eight cattle including calves. In the beginning he only had two heifers.

The limitation

The limitations of this farm are:

- a. Land access. Farmer difficult to find land available to cultivate forage. Even, if farmer find land available, they do not have enough money because price of land rented is relatively high in this area.
- b. Forage access. Natural grass and paddy straw are still accessible but it will take time and energy to obtain it because of the distance from farm to Subang District.

SECOND INTERVIEW

1. Diversity of activity

Mr Nandang started dairy business and trading of tofu waste at the nearly same time. It has been 25 years for both activities. He explained that he has enough time to do those activities because his children help him. They still have enough time to take care all cows and to do all dairy farming activities. If only doing one activity, he cannot cover all daily expenses. In addition, business on tofu waste is useful for dairy farming activity. He provides part of tofu waste to the cows from his business.

In his opinion, trading of tofu waste is more important and more profitable than dairy business. However, lack of capital make him difficult to enlarge this business. Every two days, he purchase 45 sacks of tofu waste at price IDR 15 thousands per sack and sell it at IDR 24 thousands per sack. It will be deducted with costs such as driver, fuel, and others. At this quantity, he will receive monthly income around IDR 3 million. He provides three sacks of tofu waste a day for his cows.

2. Land access

The main problem in this area is land access. This farmer has no land to cultivate forage. Land is used mainly for housing. Mr Nandang also explained that he difficult to rent land because of the high price of land rented and the availability of land. He does not have enough money. It is different with dairy farmers in Subang who can access land from PTPN (state tea plantation) because the distance is near from their farm or farmers in Gunung Putri (Lembang) where land of PERHUTANI is accessible to cultivate napier grass.

3. Forage access

As other farmer in this area, he depend on natural grass and paddy straw surrounding area and other area. Currently, availability of natural grass in surrounding area is limited. Consequently, farmers have to find forage from Subang District or other area. Sometimes (only if needed), this farmer hire an outside family worker to cut and to carry grass. He will pay IDR 75-100 thousands per day for a worker, it depends on the amount of grass.

In addition, Mr Nandang can purchase napier grass mixed with other grass at Baruajak (Different Hamlett). Price of this grass is IDR 200 thousands per tonnes. However, it is not available everyday. He has to compete with other farmers to get this forage.

If lack of forage, he adds some concentrate or tofu waste and cassava waste to cover the animal needs. He explained that this balance will produce more milk and the cow will be good enough.

4. Waste management

Nowadays, manure and waste from farm are evacuated directly to the waterways. Eventhough, he knows that it is not good for environment. He already knew the use of biogas. KPSBU (milk cooperative) officer provides extension about the benefit of biogas. KPSBU also provides a credit for biogas. However, the problem is that land availability. He had no space in the barn or near the house to install biodegester.

5. The willingness to maintain dairy farming activity, for the new generation

Eventhough, Mr Nandang has two activities, dairy business is still interisting as an activity generating income. Beside from milk selling paid by cooperative every fifteen days, dairy business also offer an income from calves selling, cows selling and others or an asset that can be sold everytime they need. Until now, his children help him on dairy farming activity. He expected that his children will continue this activity.

Monogram

	1992	1995	2000	2012	.....	2015	2016	2017
1. Activities								
dairy farming	Started with two heifers							
trading	Tofu waste							
2. Workers								
couple	Part time in dairy farming and trading							
Son	All year in trading							
Son-in-law			All year in dairy farming					
Outside family labor	All year in dairy farming							
3. land ownership								
Land owned	Small size for house and barn							
4. cultivation	(no cultivation)							
5. dairy cattle								
Calves	0	He select good female calves to be replacement stock but sometimes are sold if needed. For male calves, sometimes are sold for Idul Adha (Big day for muslim)						3
Heifer	2							3
Cows	0							2
Bulls	0							0

TP045 (Mr Yayan, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Yayan started dairy bussiness in 2004. Initaly, he received two heifers from Livestock Services of Subang District. Actually, those heifers belong to him only if he keeps and raises it. However, when he decides to sell those heifers, 40% of money from the selling will be given to the group of farmer. Those money will be given to another farmer to buy a cow or heifer. Total worker of this farm was two persons included Mr Yayan and his wife.

Before started dairy farming activity, he was working as wage worker at PTPN (Tea State Plantation). The work hour was only from 7 to 9 am. So, they have time for additional activity. He explained that as a wage worker, the income was unstable and uncertain. However, in dairy business, he had more income to cover daily expenses. Beside those activities, he also had crop farming (paddy land). Nevertheless, the product was only for family cunsumption.

He provided more or less 40-50 kg of natural grass per cow a day. Natural grass was obtained from surrounding area and land from tea state plantation (PTPN). He did not provide concentrate feed, cassava waste, or others because the income was not enough to pay all feed costs. Milk production on average was 10 liters per cow a day.

Recent activity

In the family, he is only with his wife. Actually, he has one child but he already married. The total activities to generate income are two activities, including dairy business and wage worker. Meanwhile, crop farming (paddy) activity is only to family consumption. Total 2800 m² of owned land are cultivated with paddy. Only small size of land (100 m²) are planted with napier grass.

This farmer has two cows and one female calf. Total 30 kg of natural grass per cow a day are provided to the cows, mixed with small amount of napier grass. In addition, total 5 kg of concentrate feed mixed with 8 kg of cassava waste per cow a day are given to the cows. Feeding time is three times a day. The farmer also gives water with ad libitum system. Milk production per cow a day is about 12 liters. All milk is delivered to milk cooperative KPSBU. The price depends on milk quality.

Total income of dairy business is about IDR 1 million per month. Meanwhile, as a wage worker he receives IDR 500 thousands a month. According to farmer, dairy business is more profitable than working as a wage worker.

The evolution**Building and the equipment**

Since the beginning, there is no change in term of building and equipment.

Feeding management

Initially, this farmer only provided grass to the cows. Nowadays, he already gave concentrate and cassava waste. It can improve milk production. He received those practices through extension and sharing with other farmers.

Activity of the production

Initially, this family work as wage worker and also paddy farming for family consumption. Since more than a decade, they add one more activity generating income. They received cattle from Livestock Services. Income from dairy business can cover daily expenses.

Labor

In term of labor, this family do not hire worker from outside. They only depend on family worker. Total worker since beginning is two persons.

Land use

Total 2800 m² of land are cultivated with paddy. In addition, borders of plot are planted with napier grass. This farmer also has 100 m² of land that are mostly cultivated with napier grass. Since they started dairy business, there is no change in term of land use.

Herd size

Started with two cows from Livestock Services (revolving cow), Mr Yayan now has two lactating cows and one female calf. If he sells the cows, 40% of income from this selling will be given to group of farmer. Every calves borned are selected to be replacement stock.

Husband and wife	Part time work at PTPN						
3. land ownership	Small size for house						
Land owned	2900 m2						
4. cultivation							
100 m2	Napier grass						
2800 m2	Paddy						
5. dairy cattle							
Calves	0	Female calves are selected to be replacement stock. Male calves are sold. Those calves are sold as well if needed. Total 40% of income from this selling are given to group of farmer to purchase a new cow for other farmer					1
Heifer	0						0
Cows	2						2
bulls	0						0

RF063 (Mr Suryana bin Udin, TPK Pojok, Bandung Barat)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Suryana married in 2007. After married, his wife and him worked as wage workers in a few times. Few months later, they started dairy farming activity with one lactating cow. They raised one cow from parent with a shared animal system or they call it "sistem paro". From this system, they received fifty percent of milk payment and calves borned. After calving, they had one female calf and they raised it up to be lactating cow. He also purchased a cow with credit scheme from milk cooperative KPSBU in 2009.

The workers in this farm were two persons included him and his wife. His wife helped him to clean the cows, to feed the cows and to clean the barn. He did heavier activities such as to cut and to carry the grass and to milking the cows.

Quantity of concentrate given to the cows was 5 kg per cow a day. In addition, he mixed it with tofu waste and cassava waste. The quantity of those two materials were higher than nowadays. He also provided more or less 40 kg of forage per cow a day.

Milk production per cow a day was 25-30 liters a day. As a member of milk cooperative KPSBU, the milk directly were delivered to cooperative two times a day (in the morning and afternoon). Every fifteen days, this farmer received milk payment after deducted with concentrate cost and other services.

Total land rented was around 600 m2. The price to rent this land was IDR 1 million a year. This land was cultivated with napier grass.

Recent activity

The member of family are him with his wife and his child aged 10 years old. They have two lactating cows. Beside dairy bussines, he has two additional activities generating income including trading and working with someone as a wage worker.

Quantity of milk produced is more or less 15 liters per cow a day. All milk are sold to KPSBU. Every morning and afternoon, he delivers to TPS (milk collecting point) and the officers of KPSBU receive the milk and make a notes. Price of milk depends on the quality of milk every TPS.

Land rented is about 600 m² to cultivate napier grass. He pays IDR 1 million per month. He also purchase two plots of land a month to be harvested that have been cultivated with napier grass. The price is IDR 350 thousands for two plots of land. Capacity of barn is enough for six cows but he join in the same barn with his father and brother's farm. Each of them has two cows.

He provides more or less 50-60 kg of forage (mostly napier grass and natural grass) and 10 kg of paddy straw. In the dry season, sometimes banana trunk is added due to the limitation of grass. In addition, he gives around 6-7 kg of concentrate feed mixed with 8 kg of cassava waste and 15-20 kg of tofu waste per cow a day. feeding time is three times a day.

Waste of farm are evacuated to waterways because he has no waste pit or biogas or field to transform become organic fertilizer.

The net income from dairy farming activity that he receives from KPSBU is more or less IDR 2 million a month. He explained that the additional income from trading is IDR 300 thousands a month and from being a wage worker is IDR 200 thousands a month.

The evolution

Building and the equipment.

Since beginning, this farmer join with his parent's farm. The barn has changed. The material of floor has changed from tiled roof to asbestos. In addition, feed bunk has been renovated. Previously, feed bunk was higher and nowadays was lower. He explained that after renovation, the cows looks more comfort. The total capacity of barn is six cows but only two cows for him.

Feeding management.

The quantity of forage and concentrate has changed. Currently, the quantity of feed is relatively higher. It is because he realized that more feed will affect milk production. In addition, he has additional forage resources from his neighbour. However, he worry if one day the land owner will stop to rent the land.

Activity of the production

This family has three activities generating income including dairy bussines, trading, and wage working. Dairy farming activity is their main activity. He explained that those three activities are important to cover daily expenses. In addition, he still depends on the dairy bussines as a main activity because he think that he will has routine income paid by milk cooperative KPSBU every fifteen days. This family is happy with the services from KPSBU because KPSBU not only gives services for cows but also for the farmers such as access to daily needs, access to credit with zero interest, and others.

Labor

There is no change in term of labor. The couple works together since started own dairy bussiness.

Land use

Total land used has changed. Nowadays, he has access to purchase land that already cultivated with napier grass. However, he is not sure if in the future this land still could be rented.

Herd size

Initially, he had only one lactating cow but nowadays he has two lactating cows. He does not plan to add more cows because the capacity of barn is only enough for two cows. In 2013, he purchased one cow with credit scheme from KSPBU. Last year, his cows had a health problem so he had to sell all cows. Then after, he bought two cows.

Dairy farming practices

The knowledge of dairy farming practices has improved in particular about animal health and milking. He participated some trainings from cooperative and also learned dairy practices from other farmers.

The limitation

The limitation to add more cows is capacity of barn. So until now, he raises only two cows.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Suryana and his family have three activities generating income including dairy business, wage worker (to transport tofu waste), and trading (credit balance for cell phone and gaz). They use available time after dairy farming to have other activities. The reason is that this family needs money to cover daily expenses and cost of dairy business. With only two lactating cows, sometimes it is difficult to cover expenses only from milk selling. Those activities were chosen due to flexible in term of working time. He explained that by doing those activities, he still can manage his time on dairy farming activities. He also mentioned that it is also easy to acces tofu waste if he work with someone to transport it.

He does not prefer to add another activity such as crop farming activity because it will take more time and it will also need more land. He stated that if he has more lactating cows, maybe in the future he can only focus on dairy business. It is because number of cows increase, the income will be increase too.

2. *Land access*

In this area, land is a main constrain. Price of land sold is expensive. In addition, farmers have to compete each others to get land rented. This farmer has 40 tumbak (more or less 600 m²) of land to be cultivated with napier grass. In some part, it is also cultivated with banana. He explained that it is difficult to access this land. He was lucky because he has good relationship with the land owner. According to him, two important things to access land in this area are good relationship with the owner and availability of money to rent it. If he does not have those points, the land will be given to other farmers.

3. *Forage access*

Beside depending on napier grass, this farmer also find other forage such as paddy straw and natural grass. However, nodaways availability of natural grass is limited. Mostly, empty land has border. Farmers have no access anymore for those land. For paddy straw, farmers can access it from surrounding area and other area (Subang District). In Subang District, there are many paddy farmers. Sometimes, it can be accessed for free but they need to rent a car to transport it.

At the moment, Mr Suryana does not need any worker to help him on cutting and carrying grass. If he does it, the cost will increase and income will decrease. He also mentioned that it is better to purchase fodder when he difficult to provide forage, than to hire worker. There is farmer or land owner who sells fodder (mostly napier grass) to him. The price is IDR 350 thousands per plot. This farmer will directly cut and carry grass from this plot. The owner only provide plot of land that is cultivated with napier grass. Mr Suryana needs two plots a month to cover animal needs. He stated that some farmers are also interested to purchase this plot of forage, so he must be careful to keep good relationship with the owner.

If he difficult to provide enough forage, he mentioned that he can add concentrate to cover animal needs. The cows will produce more milk with good quality. However, quantity of waste (tofu waste) is not change. If he add more tofu waste, the cows will be paralyzed easily.

4. *Waste management*

Mr Suryana evacuates all part of waste to the waterways. He does not use this manure on land rented. Those land contain much water if he add more fertilizer from barn, it will be not effective. Previously, part of waste are processed to be organic fertilizer but since he moved to a new barn, there is no space available for a waste pit. He mentioned that many horticulture farmers who find this organic fertilizer.

We also asked about the biogas. He said that extension officer from KPSBU explained positive things to have biogas. It might reduce pollution and farmers also can use biogas for cooking. KPSBU also provide light credit scheme with only pay IDR 100 thousands, dairy farmers can access biogas. He explained that he was interested to install it but he has no space available in barn to put biodigester.

5. *The willingness to maintain dairy farming activity, for the new generation*

Dairy business is still a good business. Mr Suryana explained that income from milk selling and calves selling can cover daily expenses. However, it will be difficult with only have less cows. KPSBU as a milk cooperative provide good services, not only for cows but also services for farmers. This farmer feels helpful for those services. If he does not have daily needs or even money, he can access it at cooperative.

In the future, he will let his daughter to continue family business or no. She has freedom to decide. A daughter maybe will follow her husband, so it is not an obligation to continue this business.

Monogram

	2007	2008	2009	2010	2013	2015	2016	2017
1. Activities								
Dairy farming	Started dairy bussiness with one cow							
Trading					Part time			
Wage worker					Part time			
2. Workers								
couple	All year in dairy farming							

3. land ownership	Small size for house and barn						
Land rented	600 m2 from neighbour						600 m2 from neighbour + 2 plots of napier grass
4. cultivation							
600 m2	Napier grass						
5. dairy cattle							
calves	0	Male calves will be sold and female calves will be replacement stock or sold if needed					0
Heifer	0						0
Cows	1						2

RF015 (Mr Olih Solihin, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 2005, Mr Olih Solihin started dairy farming activity. Initially, he bought a heifer with the price was IDR 9 million. He raised this heifer to be lactating cow. After calving, he sold calves to cover his daily needs or sometimes he kept a female calf to be lactating cow. When he already had two cows (since two years ago), he added more cow through credit from milk cooperative KPSBU.

Before started dairy business, he worked as a wage worker. Then, he decided to convert the activity generating income because he was thinking that income of dairy business was more higher than working as a wage worker. Every fifteen days, he receives money from KPSBU as milk payment. However, as a wage worker, he really depended on someone needs. For instance, if someone needs him to build a house, he will work and he will be paid. Under this circumstance, the income will be unstable.

He married in 2008. Before married, he worked alone in his farm. Since married, his wife help him in the barn after she got home from working in Lembang. His wife worked as a wage worker at strawberry garden.

Quantity of forage given to cows was fewer than nowadays. He explained that at the beginning he did not know good farming practices, included the amount of forage feed and concentrate feed. He provided 6 kg of concentrate feed purchased at KPSBU. Feeding time was two times a day. Milk production a day was 10 liters per cow. He mentioned that the milk production was lower than at present time. The income from milk selling was IDR 200 thousands due to low price of milk.

He had more or less 1500 m2 land access at PTPN (State tea plantation). This land was cultivated with napier grass. Beside this land, he also looked for natural grass in surrounding area to have enough forage for cows. Even, in the dry season, he added paddy straw to feed the cows.

Recent activity

He has a wife and a young daughter (5 years old). Until present, his wife helps him in the farm but after she gets home from working in Lembang. This family has two activities to generate income, including dairy farming and wage working.

Population of cow in this farm is three lactating cows. Milk produced is more or less 42 liters per three lactating cows. Farmer gives 40 kg of forage per cow a day which mostly napier grass mixed with natural grass. Land access at PTPN (state tea plantation) is 1500 m² to produce napier grass.

In addition, he provides 8 kg of concentrate feed purchased from KPSBU mixed with 10 of cassava waste per cow a day. He explained that nowadays he uses cassava waste because he was thinking that cassava waste can produce more milk. He was inspired from another farmer who used this material to feed the cows.

The income from milk selling is more or less IDR 3-3,5 million a month. It depends on milk produced and price of milk. However, talk about dairy business is not only from milk selling, but also from calves selling and others. He explained that he could built a house due to calf and cow selling.

Waste from this farm is still evacuated to the waterways or rivers. He mentioned that there is no neighbour who protests because most of people surrounding area are dairy farmers too.

The evolution

Building and the equipment

This farmer received barn renovation from Dairy Development Project in Ciater area. Feed bunk and drinking system has changed. Feed bunk was made by ceramic and lower than before. Drinking system are now automatically refilled (ad libitum system). Renovation of barn are very useful to increase comfortability and productivity of cow.

Feeding management

Feeding time are three times a day. Previously, feeding time was only two times a day but since he received training and extension from NGO and cooperative, he changed it. Improving feed management might increase production of milk.

Activity of the production

This family has two activities generating income including dairy business and work as wage workers. They have those activities since beginning of dairy business. Mr Olih Solihin previously worked as a wage worker then he decided to be dairy farmer because this business is more profitable.

Labor

Since beginning, a couple work together. However, a wife only works for part time because she has another activity in Lembang. There is no change in term of labor.

Land use

Total 1500 m² is accessed since they started dairy business. Those land are land of PTPN (state tea plantation). However, farmers can access those land to be cultivated with napier grass.

Herd size

Started with only one heifer, this farmer now has three lactating cows. Every female calves borned are selected to be replacement stock but sometimes are sold (depends on their needs).

Male calves are usually sold after three months old. Two years ago, he added more cow through credit from KPSBU.

The limitation

To add more cows, the difficulties are: a) availability of money to purchase a new cow and b) calves are sold because they need money to cover daily needs.

He expected that he has at least five lactating cows. It can be good for dairy business.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Olih Solihin works only on dairy farming activity. His wife works as wage worker in Lembang. After coming home, she helps him on cleaning barn and cleaning animal. They have no difficulty to manage their time on dairy business. eventhough, his wife works as wage worker, she can still help him on dairy farming activities. Income from dairy business is a main income. However, sometimes it is not enough to cover all daily expenses. Income from his wife is an additional income to cover it. Actually, Mr Olih Solihin wants to add more activity such as crop farming but he does not have land. Even, until now he manages cows in barn belong to his parent.

2. *Land access*

Like other farmers in Ciater area, land access is not a main constrain for dairy farmer activity. He mentioned, almost eighty percent of farmers can access land of PTPN. They can cultivate napier grass at unproductive or unused land (land that is not planted with tea and other vegetables). Nowadays, this farmers has more or less 1500 2 of land to be cultivated with napier grass. He access those land since he started dairy business.

3. *Forage access*

To provide forage for cows, this farmer do not depend only on land of PTPN. He also find natural grass in surrounding area. Natural grass is still easy to find. It is available to feed his cows. He does not need to buy from others because the quantity of natural grass from surrounding area is enough to feed the cows. In addition, he can also provide paddy straw. He mentioned that paddy straw could be obtained for free. He only helps paddy farmers, and he will receive it from them.

In case of emergency, Mr Olih Solihin does not need outside workers to help him to provide grass for cows. He and his wife can be enough to provide grass because they only have small number of cows. In addition, if they difficult to find forage, they will add concentrate. Mr Olih Solihin mentioned that adding more concentrate can produce more quantity and quality of milk.

4. *Waste management*

Mr Olih Solihin evacuate waste to the waterways. He mentioned that actually it is not difficult to access biodigester. KPSBU can provide it to all farmers. Farmers only pay IDR 100 thousands a month which directly deducted from milk payment. Even Livestock Services of Subang Regency provide biodigester for free to farmers in this area. Even so, this farmer do not install biodigester to process waste to be biogas because he has no space available in barn.

5. *The willingness to maintain dairy farming activity, for the new generation*

Mr Olih Solihin mentioned that he want his children to continue their family business. This farmer said that dairy business is a good business. Income from milk selling can cover daily needs and income from calves selling can be for saving. Those income are very interesting.

Monogram

	2005	2006	2007	2008	.....	2015	2016	2017
1. Activities								
Dairy business	started with a heifer							
Wage worker				Part time				
2. Workers								
husband	All year in dairy business							
wife				Married and started to help dairy business (part time)				
3. land ownership	Small size for house and barn							
Land access	1500 m2 of PTPN land							
4. cultivation								
1500 m2	Napier grass							
5. dairy cattle								
Calves	0	Female calves are selected to be replacement stock (sometimes are sold if needed. Male calves are sold at three months old						0
Heifer	1							0
Cows	0					1 (purchase it through credit scheme of KPSBU)		3
bulls	0							0

RF054 (Mrs Acih, TPK Pasir Ipis, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mrs Acih married in 1975. After married, her husband worked as a wage worker for three years. In 1979, she started dairy farming with his husband. She learned from her family about the dairy farming practices. The family of her husband and her were also dairy farmers. She started with two heifers that have been received from her brother with "sistem Paro". The idea of this system is that someone raises the cow and then the products such as the milk and the calves will be shared together between the owner and the person who take care of the cows. "Sistem Paro" are well known in Indonesia particularly in West Java. The male calf usually were sold after two to three months old and the female calf were raised to be a lactating cow. Sometimes, the male calf plus additional money were changed to female calf or heifer with other farmers.

Since the beginning, this family only foccus on the dairy farming activity. The couple worked together in this activity. In 1989, she changed the member name registered at milk cooperative KPSBU from his husband name to be her name. In 2001, her husband had a desease and passed away. She continued dairy farming activity until present.

The capacity of the barn at the beginning was less than four cows. They provided more or less 40 kg of mostly natural grass and napier grass per cow a day. They received the grass from surrounding area and forest because they had no owned land to cultivate napier grass. The quantity of concentrate and cassava waste were around 7 kg and 13 kg per cow a day. Water was provided three times a day which amounted 10 liter each time.

As a member of KPSBU, all milk were sold to milk cooperative. She also received some services from cooperative such as AI service, concentrate feed, credit, and others.

Recent activity

Nowadays, Mrs Acih still foccus only on the dairy farming activity. She has five lactating cows, one male calf and one female calf. Normally, every year, the cows are calving and the female calves will be kept in the barn but the male calves will be sold or be changed. Her youngest son help her in dairy farming activity. The capacity of the barn is enough for six lactating cows. The milk production is 80 liter per five lactating cows a day. All milk are sold to KPSBU and she receives the milk payment every fifteen days. Since the last two years, this farm was the farm with the highest milk sold to cooperative.

Usually, she provides more or less 45-50 kg of forage feed per cow a day. The forage feed are obtained from the land rented from PERHUTANI. In addition, they find the natural grass from surrounding area. The quantity of concentrate feed given to the cow is around 5-7 kg per cow a day. They also provide to feed the cows more or less 13 kg of cassava waste per cow a day. In the dry season particularly, paddy straw are mixed with napier and natural grass. The quantity of the paddy straw is 20-25 kg per cow a day which can be obtained from another area (Subang regency).

The total land use (from collaboration between KPSBU and PERHUTANI) to cultivate napier grass is about one hectare. The cost of the land rented is directly deducted by KPSBU every fifteen days. In the local name, they call it “sharing rumput”. In other words, KPSBU ask to PERHUTANI to use the land in the forest to be cultivated with grass. It is to anticipate the limitation of the forage for KPSBU member.

They use biogas to manage the waste from the farm. The gas is used to cook. From this technology, they can reduce the monthly expenses. Some of waste are also used to be an organic fertilizer for vegetable and flowers. Usually, they sell it to the horticultural farmer every two months. They receive more or less IDR 150 thousands every two months.

The income from the dairy farming activity is quite good. They receive more or less IDR 8 million per month from KPSBU (after deducted with the concentrate feed and the land rented). The cost of cassava waste is about IDR 1,5 million per month. So, the net income is around IDR 6,5 million per month.

The evolution

Building and the equipment.

The capacity of the barn has changed. Previously, it was only enough for less than four cows but currently is enough for six lactating cows. She renovated the barn because every year she has more cows and plans to add more cows in the future. The biogas was installed to decrease environmental pollution.

Feeding management.

There is no change about the quantity of concentrate feed and cassava waste to feed the cows. But in the total, they need more because the number of the cow increased. Total quantity of forage feed has slightly changed. Nowadays, they provide more forage feed compared with the situation in the past. The reason is that they must look for the natural grass or napier grass from surrounding area even in the area away from the farm. Because they have no owned land to be cultivated with napier grass. The change is also about the kind of forage that they provide to the cows. In the past, they only gave natural and napier grass but currently they also mix natural and napier grass with paddy straw particularly in the dry season. The quantity of the napier grass are much lower than in the rainy season so it is not enough to feed all cows they have. Totally, they need more grass in the present time than in the past.

Activity of the production

Since the beginning, this family focus only on dairy farming activity to generate income. Mrs Acih mentioned the reason is that they have no owned land to other crop farming activities. In addition, all of their big family had a background as a dairy farmer. The big family inspired her to have dairy business too.

Labor

After married, the couple worked together in the farm. However, in 2001 because of her husband's healthy problem, she worked alone. However, since 2007, her youngest son helped her to take care of her dairy business. They develop together their dairy farming activity.

Land use

Initially, there was no land used to dairy farming activity. They have only small land to build the house and the barn. Consequently, they had to find the grass from surrounding area or even in the area away from the farm. However, since 2002, KPSBU and PERHUTANI collaborate to use the land in the forest to be cultivated with napier grass. This farmer use the total 1 hectare of land to cultivate the napier grass as a source forage feed for their cows. It could save their time and energy to look for the forage. In addition, it is enough to feed their all cows in particular in the rainy season.

Herd size

In the beginning, she only had two heifers that she received from her brother with "sistem paro". Gradually, she had more cows because she kept the female calves and she also sold the male calf if needed. Nowadays, this farmer has five lactating cows and two calves. This family plan to add more cows. Eventhough, the barn only enough for six cows but she plans to have more than six. It can be shared animal "sistem paro". In other words, another farmer will take care of the cows and she will have passive income from it. It could be interesting because she will have additional income and keep their physical capital increase.

The limitation

The forage particularly in the dry season is very limited. Consequently, they use paddy straw to cover it. They also have difficulty to add more cows in their own barn because the capacity of the barn is only sufficient for six cows. Alternatively, she will ask another farmer to take care of the cows with "sistem paro".

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mrs Acih has only one activity generating income. She focus on this business because she wants have optimal income. If he add more activity, dairy farm will be unwell

managed. Nowadays, she has five lactating cows. Income from milk selling can cover all daily expenses. She mentioned that if number of cows is less than four, maybe another activity need to be added to have more income. She said, six cows are enough to have ideal dairy business. If more than that, workers need to be added and also land for forage. This farmer often receive achievement from KPSBU as a farm who produce highest quantity of milk during a year.

2. Land access

Land availability is somehow still a constrain in this area but not a main problem. Eventhough, farmers can access land of PERHUTANI in the forest but the distance is relatively far from farm. Mrs Acih has more or less one hectare of land access in forestry land to be cultivated with napier grass. She mentioned that this size of land is enough to feed all cows. Every fifteen days, he pay it to KPSBU (directly deducted from milk payment). Those land can be accessible as long as farmers have money to pay every fifteen days.

3. Forage access

This farmer also access natural grass and paddy straw to feed the cows. Paddy straw is added particularly in the dry season. She mentioned that availability of natural grass is now limited. It is difficult to find it in surrounding area. It is because the number of farmers increased. They need forage to feed the cows. To cut and to carry grass, she is helped by her son and sometimes nephew but no need to hire outside worker.

In addition, it is possible to purchase fodder from neighbour. It is not easy to access it, but because she has good relationship with neighbour, so it is easier. She must pay IDR 250 thousands per plot of land (more or less 1400 m²) that have been cultivated with napier grass. She cut and carry those grass from those land. She only access it every two months.

She said that in case of emergency, she can add more concentrate and cassava waste to replace some quantity of forage. It can cause high production of milk. She also explained that she found no risks when do this practice. Cow's health are still in a good condition.

4. Waste management

Waste of this farm is also well managed. Manure are processed to be biogas and organic fertilizer. Even, those fertilizer are sold to crop farmers. Biogas is used for cooking. She received it from KPSBU. KPSBU even provided subsidy of IDR 3 million to install this biodigester. The rest will be paid through credit scheme every fifteen days (milk payment). This waste management were provided by KPSBU through training and extension.

5. The willingness to maintain dairy farming activity, for the new generation

Mrs Acih said that dairy business is a good business. All daily expenses can be covered by this business. The income is not only from milk selling but also from calves selling. Farmers receive routine income every fifteen days from milk payment by KPSBU. Additional income will be received when they sell calves. Calves can be for saving but also for cover daily needs. The most important thing also on this business is that she feels free and independent.

His son will continue her family business. Since ten years ago, his son always help her on dairy farming activity. She expected that her son can enlarge this family business.

Monogram

	1975	1979	2001	2002	2007	2015	2016	2017
1. Activities								
Wage worker	Husband							
dairy farming	Started with 2 heifers from "sistem paro"							
2. Workers								
Husband	All year							
Couple	All year in dairy farming							
Wife	All year in dairy farming							
Son	All year in dairy farming							
3. land ownership								
Land rented	1 hectare from collaboration between KPSBU and PERHUTANI							
4. cultivation								
10000 m2	Napier grass							
5. dairy cattle								
Calves		0	Male calves will be sold and female calves will be replacement stock					2
Heifer		2						0
Cows		0						5

RF050 (Mr Suherman, TPK Pasir Ipis, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Suherman started his own dairy bussiness in 1992. Previously, he already helped his parents to raise dairy cows. In 1992, he received one female calf from his parents and then he raised up to become lactating cow in two coming year. A female calf from this lactating cow was also kept in his farm to be a lactating cow, so he had two lactating cow and one calf in 1996. From 1997 to 2000, he sold one lactating cow to fund his wedding party. He married in 2000 and registered formally as a member of milk cooperative KSPBU (before that he joined with his father for the registration at KPSBU). He was helped by his wife in dairy farming activity. In 2001, his first son was born and in 2007 the second one was born. He sold two lactating cows to build his house. Generally, this farmer kept the female calves to replace the old cows but male calves have been sold after three to four months old. Sometimes, he exchanged a male calf plus money to heifer or lactating cow with another farmer.

He had a barn which was only enough for four cows. He provided more or less 40 to 45 kg of forage feed (napier grass and natural grass) per cow a day. He also gave 5 to 10 kg of a high quality concentrate feed per cow a day. The feed management in the dry and rainy season was relatively similar. The milk production was high relatively which was around 25 to 30 liter per lactating cow a day.

In 2000, he had two activities generating income included dairy farming and crop farming (broccoli and tomatoes). He had more or less 2100 m² of land that mostly have been cultivated with broccoli and tomatoes. Only small of it (less than 500 m²) that have been planted with napier grass. In addition, he rented 1400 m² of land in the forest to be cultivated with napier grass. This land he received from the collaboration between KPSBU with PERHUTANI. He then stopped crop farming in 2003. He received it from his parents.

Recent activity

At the present time, Mr Suherman and his family foccus only on the dairy farming activity. Although, sometimes he fills his available time to be a “ojek” (taxi motor) driver. The income from “ojek” according to him is not significant. It is only enough to buy cigarette. In other words, he mentioned that he could not involve this activity to generate income.

This farmer have three lactating cows and one heifer. The barn is enough for six lactating cows. Total land access to cultivate napier grass are 3500 m² included 2100 m² owned and 1400 land rented. The quantity of the forage feed he provides for a cow a day is 35 to 40 kg. In addition, he provides 10 kg of concentrate feed purchased from KPSBU and 13 kg of cassava waste per cow a day. The milk production today is 52 liter per three cows a day.

The total workers are three persons included him, his wife and his son. As a member of KPSBU, he must sells all the milk to the cooperative. The milk price he receive is IDR 4800 per liter of milk. Every month, he delivers more or less 1500 liters of milk to the cooperative. The net income (already deducted by concentrate feed cost and land rented) from KPSBU is around IDR 4,5 million a month.

The evolution

Building and the equipment.

The capacity of the barn has changed. Previously, it was only enough for four cows but currently is enough for six cows. He renovated the barn because he plans to add more cows in the future.

Feeding management.

The quantity of the forage feed has changed. In the present time, the quantity of forage feed per cow a day is lower than in the past. The reason is that the number of cow is higher and the land available to cultivate forage is still the same. In addition, it is difficult to find natural grass because the number of farmers and the cows in surrounding area increased. Even in the dry season, he has to add paddy straw to feed the cows. This paddy straw was used since a few years ago.

He mentioned that the quality of the concentrate feed is different compared with current situation. The quantity of concentrate feed is higher than it was. In addition, since a few years ago, he added cassava waste to improve milk production.

In the past, a good cow genetically with this kind of feeding management could produce more milk.

Activity of the production

In the beginning, this family had two activities generating income included dairy farming and crop farming (broccoli and tomatoes). However, he stopped the crop farming in 2003. The reasons were that the quantity and the price of the product was unstable. He mentioned that “this activity is like a gambling. Sometimes, you will receive good price and you will have

much money from it buy sometimes when the price is not good, you will pay the loss". Compared to crop farming, the dairy business have a stable market because the presence of the milk cooperative.

Labor

After married, his wife helped him in the dairy farming activity. Since four years ago, his son also helped him in this activity. After come home from school, his son helped him to cut the forage, to clean the barn and to milking. He does not oblige his wife and his son to help him but as a family, they have sense of belonging to work together.

Land use

Intially, this family use their owned land to cultivate broccoli and tomatoes. But since, they stopped crop farming in 2003, they converted the total 2100 m² of land to cultivate napier grass. It was needed because the number of cow increased.

Herd size

In the beginning, he only had a calf from his parent. Time by time, he had more cows and he also sold the male calf. Female calf were kept in the barn to be a lactating cow. Usually, he sells the cow when he needs money such as a wedding party, a home building, and a motorcycle for his son. Nowadays, he has four animal unit and he plans to add more cows in the future. He said the land is still enough if he add one or two more cow.

The limitation

The animal genetic is not as good as before. He had a cow produce high milk but had a health problem and dead.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Suherman and his family has two activities generating income including dairy business and ojek driver (taxi motor). Main activity is still dairy business. He explained that ojek driver is only additional activity because the income from this activity is very small. He had crop farming activity but since more than ten years ago, he stopped this activity. It was because the price and the income are unstable.

He explained that dairy business cannot cover all daily expenses. It is because he only has three lactating cows. He expected that if he has five lactating cows, he will foccus only on dairy business. The income will be enough to cover all daily expenses from milk selling.

He can manage his time for both activities. On dairy farming activities, his wife help him. Ojek driver is only to use available time after doing dairy farming activities. Other activity such as trading is not fit with him and his family. He mentioned that the competition on trading is high and also need money as a capital. It is better use those money to add more cows.

2. *Land access*

Farmers in this area can access land of PERHUTANI (state forestry office) collaboration between KPSBU and PERHUTANI. At the beginning, forestry land (owned by PERHUTANI) was burnt. After this disaster, those land became empty land. Farmers then cultivated those land with napier grass. PERHUTANI protested.

Therefore, KPSBU as an umbrella of dairy farmers in this area tried to negotiate with PERHUTANI. Win-win solution was that farmers have to pay those land to KPSBU and KPSBU pay it to PERHUTANI.

Every farmers can access those land if they have a willingness, time and also money to pay it every fifteen days. The distance of the land with farms is relatively far and not good condition, so it will need time and willingness. It will also need money, because farmers have to pay it to KPSBU every fifteen days (it is deducted from milk selling). Mr Suherman itself has 1400 m² of land access to be cultivated with napier grass. He also has 2100 m² of land that are also cultivated with this grass.

3. *Forage access*

This farmer add natural grass to cover animal needs. In addition, paddy straw will be provided particularly during dry season. He explained that availability of natural grass is now limited in surrounding area. He find natural grass from other district. He mentioned that previously, to cut and to carry grass took five until eight hours a day because of distance. Since, he has motorcycle, this activity only takes less than five hours.

Until now, he does not need to hire an outside worker. It is because the demand of forage is not too high. It can be covered by him and his family. In this area, it is not common to buy and to sell fodder (napier grass or natural grass). However, in case of emergency, farmers can help each others to provide grass to feed the cows.

He explained that if he difficult to provide forage, he does not add more concentrate. It is because add more concentrate will increase cost and it cause decreasing income. In addition, it might cause cow's paralysis. It is better to have good balance between concentrate and forage.

4. *Waste management*

Waste of farm is well managed. Part of waste are evacuated to biodigester to be biogas. Residual from biogas are processed to be organic fertilizer. This fertilizer is sold to crop farmers. Mr Suherman said that he received those practices from training and extension provided by KPSBU. For installation of biodigester, he was also helped by KPSBU through credit scheme. Every fifteen days, IDR 50 thousands is directly deducted from milk payment.

5. *The willingness to maintain dairy farming activity, for the new generation*

This farmer also said that dairy business is a good business. About 70-80 percent of daily expenses can be covered by this business. The constrain is only capital to add more cows. Income from milk selling will be used for daily needs. The rest will be covered by calves selling.

Nowadays, his son is studying at vocational school of livestock in Lembang. He expected that his son will continue his family business or work at KPSBU. He explained that his son has a desire to be a dairy farmer. It can be seen when routinely his son help him on dairy farming activity. In addition, his son often invites his friends to their home to learn about dairy faming practices.

Monogram

	1993	2000	2001	2003	2012	2015	2016	2017
1. Activities								
Crop farming		Broccoli and tomatoes			Stop activity			
Dairy farming	Helped his parent's dairy farm	Own dairy bussiness						
Taxi motor driver					Additional activity			
2. Workers								
Couple		All year in crop farming and dairy farming		Stop crop farming and focus in dairy				
Husband	All year with his parents				Part time taxi motor driver			
Son		Part time (after come home from school)						
3. land ownership (date of acquisition)		2100 m2 received from his parents in 2000						
Land rented					1400 m2 from PERHUTANI			
4. cultivation								
2100 m2		Broccoli and tomatoes			Napier grass			
1400 m2		Napier grass						
5. dairy cattle								
Calves	1	Selected female calves will be replacement stock (sold only if needed). Male calves will be sold.						0
Heifer	0							1
Cows	0	1 have been sold for a wedding party					1 have been sold for a motorcycle	3

RF005 (Mr Ano and Mrs Yoyoh, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Ano and Mrs Yoyoh is a couple. They started dairy business in 2007 when private company collaborate with milk cooperative (KPSBU) had dairy development project in Ciater area. They were invited by another farmer (Mr Emo) to be received dairy cattle. At the beginning, three pregnant heifers were provided by the project via credit scheme. Previously, they worked as labor at PTPN (state tea plantation). Mrs Yoyoh still working on tea plantation but his husband decided to quit after started dairy farming activities. He had to choose between to be a worker or to be a farmer. It takes a lot of time on dairy farming activities particularly to cut and to carry grass, so time available for other activity is limited.

They had also sheep farming before dairy farming activity. However, income from this activity was low and then they preferred to convert with other activity. The main reason to be dairy farmer is that the income from this activity is interesting. Eventhough, it takes a lot of energy,

dairy business provided income from milk selling, calves selling and even cow selling. They mentioned that they could renovate home, purchase motorcycle and land, or others.

Total workers of this farm were two persons (a couple). A husband foccused on this activity all year but a wife was only to help him to feed the cows, to clean the barn and to clean the cows. Heavier activities were done by husband such as to cut and to carry grass, as well as to milking the cows.

Total 400 m² of own land have been used to cultivate napier grass. However, this farmer also accessed unused land of PTPN. Day by day he enlarged size of land. After to cut the grass, he cultivated napier grass. Therefore, at the end total land access was more than one hectare. Every farmers in this area have each borders for this land access. It is to declare “it is mine” and “it is yours” unformally.

To feed the cows, more than 50 kg of forage (mostly napier grass) was provided per cow a day and also total five kilogram of concentrate mixed with small amount of cassava waste were added. This farmer mentioned that they did not know good dairy farming practices. Quantity of feed was relatively lower than nowadays. Then, they learned a lot from KPSBU extension officer and other farmers how to practice dairy farming correctly. They also received training of this practices from cooperative in Lembang area.

Milk production a day per cow was only 8 liters. As a member of cooperative, all milk were sold to cooperative. The milk payment was done every fifteen day after deducted with feed cost (concentrate cost, reimburs of credit, and others). They explained that the income from milk selling was only IDR 150 thousands a month due to low quantity of milk sold and high production costs.

Recent activity

There are four persons in this family at the beginning including a couple and two children. Nowadays, one child was married and lives separately from the family house eventhough in near location. Therefore, it remains three persons in the house.

Currently, total workers of dairy farm are three persons including a couple and youngest child. Mr Ano and his son work together to do dairy farming activities such as to cut and to carry grass, to milking the cows, to feed cows, to clean barn, to clean cows and others. Meanwhile, his wife helps them on feeding cows and cleaning barn after working at tea plantation (usually after 13h00).

Total population of cow is eight dairy cattle including three calves, one heifer, three lactating cows and one cow in the dry period. To feed the cow, every day more or less 50 kg of forage (mostly napier grass) is provided per one cow. This farmer obtains forage from around five hectare of land access including 1,25 hectare own land and 3 hectare land of PTPN. In addition, 10-11 kg of concentrate mixed with water and 10 kg of cassava waste are added to feed a cow a day. Concentrate feed is purchased from KPSBU and will be charged every fifteen days (milk payment). Meanwhile, cassava waste is bought from private trader.

Total milk production a day is about 58 liters from three lactating cows a day (almost 20 liters per cow). This quantity is higher than couple years ago which only 8 liters of milk a day. The monthly income from milk selling is IDR 4,5 million. In addition, income from working at tea plantation is around IDR 900 thousands a month.

The evolution

Building and the equipment

Initially, they did not have barn and then barn was shared with other farmer. After a year, they had their own with capacity for three cows. This barn have been renovated. Nowadays, the barn is enough for 14 cows more or less.

Technology

The biogas was not installed yet. Limited space surrounding farm area is main reason this technology was not installed. In addition, milking machine is still too expensive to be used in this farm. Feed silage is actually feed technology that already learned. However, it does not applied yet.

Feeding management

Quantity of forage and concentrate are increased year by year. Improved dairy farming practices through training and extension is the main reason.

Activity of the production

Converting activity generating income from worker to be dairy farmer is not an easy thing. Low of experience on dairy farming practices made them difficult at the beginning. Since, they knew the knowledge about the practices, the result is steadily increased. His wife still can help this family business after going home from working.

Labor

At the beginning, this farmer only worked with his wife on this business. However, nowadays, their child can help them on dairy farming activity.

Land use

In Ciater area, land access is not a main problem. Farmers can access land of PTPN. This farmer can access around three hectares to be cultivated with napier grass. In addition, he also purchased land after selling cows or calves. Total more or less five hectares of land are planted with napier grass. However, the distance from the farm are relatively far. So, this farmer plan to buy land close to the farm to be more efficient.

Herd size

The population is increased compared with the initial condition. Even, some cows and calves have been sold to cover daily needs or to buy other things.

The limitation

The limitation of this farm is about forage access. Eventhough, land is easy to access but in the rainy season, they difficult to cut and to carry grass from land of PTPN because due to slippery and muddy. In the dry season, grass is realtively difficult to grow.

SECOND INTERVIEW

1. Diversity of activity

Initially, this family worked as wage worker at PTPN since more than twenty years ago. Since 2007, Mr Ano converted as a dairy farmer and a year after, he focused only on dairy farming activity. He took this option because there was no time available on other activities. They mentioned that decision to quit from PTPN was a good decision. They explained that income from dairy business is more profitable than sheep farming. This business offered interisting income not only from milk selling but also cows and calves

selling. Now, Mr Ano can more focus on dairy farming activity. Time availability would be more efficient to obtain forage to feed the cows.

Until now, this family still have two activities generating income because Mrs Yoyoh (Mr Ano's wife) still continue working as wage worker at PTPN. Part time, she helps her husband on dairy farming activity. She is still continue working at PTPN to have pensions salary after retired as an additional family income.

She explained that she has enough time to cover both activities. She works as a tea worker only until at noon. And after, she can help her husband on dairy farming activities. However as a consequence to have more than one activity, this family must hire worker from Mrs Yoyoh's family (brother of Mrs Yoyoh) to cut and to carry grass. He is paid IDR 10 thousands per bundle. They need additional two bundles a day for all cattle. Totally, additional cost is IDR 20 thousands per day.

2. Land access

Total land access at PTPN is about three hectares. All land were located at unused land. In other words, this land is not planted with tea. Therefore, farmers cultivate napier grass. However, the location is far from farm.

Principally, those land can be accessed by every farmers as long as they only cultivate napier grass. Those land will be more useful if it is cultivated with grass. If no, she explained, the land will be more like jungle and unmanaged. Those land access also depend on willingness of farmers itself because most of them are located far from farm. The risk is that when one day PTPN will use those land to cultivate fruits or vegetable then farmers will have no more land access.

3. Forage access

Until now, they have no difficulty to have forage because land access is relatively large. Therefore, they do not need to provide paddy straw or natural grass to feed the cows. According to Mrs Yoyoh, natural grass is difficult to find particularly at location near farm because some farmers compete to obtain it. Even, she added, it is easier to find napier grass than natural grass.

To help this farmer on cutting and carrying grass, they hire brother of Mrs Yoyoh to do it. He will be paid IDR 20 thousands a day to obtain two bundles of napier grass. Usually, one bundle is about 40 kg of grass. Only in case of emergency, they can buy grass from other farmer. The price is about IDR 10 thousands per bundle.

Mrs Yoyoh explained that quantity of grass provided to cow is relatively higher (50 kg per cow a day). However, quantity of cassava waste is also higher (8-10 kg per cow a day) than couple years ago. Cassava waste can improve milk production.

4. Waste management

Currently, waste of dairy farm are directly evacuated to waterways. She explained that this waterways will be end on paddy land so it will be good to fertil those land. No neighbours protest about this activity because the waterways is relatively big and no one disturbed.

In term of waste management, actually, this farmer already received many informations about benefits of biogas through extension of KPSBU. In addition, KPSBU also has collaboration with others to install it with profitable credit scheme. Farmers only pay IDR 100 thousands a month for five years.

She also explained why this family did not install biodigester yet. It is because they have no space available in the barn to install it. In fact, they really want to use this technology so that they can use biogas for cooking.

5. The willingness to maintain dairy farming activity, for the new generation

This dairy business is very interesting for the family. This business is really profitable and can cover all daily expenses. They like this activity. In addition, they expect their children particularly the youngest one will continue this family business. She mentioned that her son helps them on dairy farming activities and have good motivation to be a farmer.

Monogram

	2007	2008	2012	2013	2014	2015	2016	2017
1. Activities								
dairy farming	Started with three pregnant heifers from project							
Wage worker	Tea plantation (PTPN)							
2. Workers								
Husband	Part time as wage worker and dairy farmer	All year in dairy farming						
Wife	Full time as wage worker and part time as dairy farmer							
Son					Part time as dairy farmer after coming from school			
3. land ownership								
Land access	0	Increase steadily year by year						3 hectare
Land owned	400 m ²	Purchase land by selling cows/calves						12500 m ²
4. cultivation								
400 m ²	Napier grass							
4,25 hectare	Napier grass							
5. dairy cattle								
Calves	0	He select good female calves to be replacement stock but sometimes are sold if needed. Usually, for male calves are sold						3
Heifer	3							1
Cows	0							4
Bulls	0							0

PS057 (Mr Asep Kurnaedi, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Asep Kurnaedi started dairy farming activities since 2007. At the beginning, he was proposed by his brother to have dairy cattle through credit scheme of Danone. Total of three cattle was provided in august 2007. Before dairy business, he was a driver of taxi motor. He raised those cattle with his wife. The male calves usually are sold at three months old and

female calves are selected to be replacement stock. Sometimes, he sells those calves too only if needed. Since two years ago, one cattle was purchased through credit scheme from KPSBU (milk cooperative). This farmer joined of this cooperative since nine years ago.

A couple work together since beginning. Only if they are tired, a worker will be hired particularly to cut and to carry grass. Usually, they hire worker as long as ten days a month. They had no experience on dairy farming before but they learned a lot from extension officer of KPSBU and other farmers.

Total 1000 m² of land owned were cultivated with napier grass. The availability of forage was limited because only depend on own land. However, since 2013, land of PTPN (state tea plantation) was accessible for him. Quantity of forage provided to the cows was lower than now. A total five kg of concentrate was given to cow a day. In 2008, this farmer started to provide cassava waste. He explained that he was inspired by other farmers.

Milk production was much lower than now. A total only five liters of milk per cow a day was produced. It was because this farmer had no experience on dairy farming before. The difficulty was mainly on feeding management. The monthly income from milk selling was only less than IDR 1 million (around 75 USD). Even he explained, he received only IDR 2 thousands a month because it was directly deducted with concentrate feed cost and reimbursment of credit. In addition, if the cows in the dry period (no produce milk), the income was only enough to pay concentrate feed.

Recent activity

In the family, there are three persons including a couple and a child at secondary school. Actually, they have another child but now the child was married and moved to Bandung (another district). This family foccus only on dairy business. Beside a couple, sometimes they hires worker to help them on cutting and carrying grass.

The population of cattle is seven cattle including two calves, three cows in the dry period, and three lactating cows. Total 1,1 hectare of land including 1 hectare of PTPN land and 0,1 hectare own land are accessible to cultivate napier grass. This farmer provides more or less 25-30 kg of grass which mostly napier grass to feed a cow a day. In addition, more or less 7 kg of concentrate mixed with 7 kg of cassava waste are given to a cow a day.

Milk production a day per lactating cow is about 13 liters. As a member of cooperative (KPSBU), all milk are sold to cooperative and milk payment will be done every fifteen days. It is already deducted with concentrate feed but cassava waste is excluded. Biogas was installed since 2012 via credit scheme from KPSBU for five years.

In the future, this family will foccus on dairy farming activity. However, Mr Asep mentioned that he expects to have crop farming activity but he will hire worker to manage it. The age (already old) and the health (have asthma) are main reason why he cannot do everything by himself. In addition, this farmer can only take care 5 lactating cows. If more than that, they need to hire worker.

The evolution

Building and the equipment

Since beginning, barn have been renovated three times. It was done to make cows feel comfort. Part of barn that have been renovated were floor, water bunk, and feed bunk. Water bunk is

now automatically refilled system (*ad libitum*). Feed bunk was made by ceramics and parallel with floor. It is easier to clean this feed bunk from feed residual. Feed bunk and water bunk were renovated by dairy development project in Ciater.

Technology

The biogas was installed since five years ago. It can reduce the evacuation of waste to the environment. Manure is processed to be gas and it is useful for cooking.

Feeding management

Cassava waste was added a year after started dairy farming activity. It was inspired by other farmers because they believe that cassava waste can improve milk production. Quantity of forage was increased due to land access. Quantity of concentrate improved due to the increase of knowledge about dairy farming practices.

Activity of the production

Only dairy farming activity is done for this family. Change from driver to be farmer was chosen. The reasons was the income is relatively stable. Every fifteen days, milk payment was conducted by cooperative. In addition, the income from calves selling is also interesting, at least for saving.

Labor

Since beginning, a couple work together on this business. However, when they get tired or not in good condition, they hire worker. Actually, the worker is still in the big family.

Land use

For farmers in this area, they have not too difficult to access land compared with farmers in Lembang area. Since 2013, this farmer had one hectare of land access to PTPN. Previously, they only depend on their own land because no land available at PTPN at that time. If any, might be the distance is too far from farm.

Herd size

The population increased but same with other farmers, they sell calves if they need money. So that is why the population is relatively stable. In addition, this farmer has no good power and energy to take care more than five lactating cows.

The limitation

The limitation of this farm is:

Energy and power. Farmer has illness (asthma) and already old. They will need to hire worker to help them on dairy farming activity if they have more than five lactating cows.

SECOND INTERVIEW

1. Diversity of activity

Mr Asep started dairy business in 2007 helped by dairy development project between private company and milk cooperative KPSBU. Since the beginning, he only focuses on dairy farming activity. The main reason is about power and willingness to have own business. Since he is old and has asthma, he prefer to have only one activity. Even on this activity, he needs to hire worker to help him on cutting and carrying grass.

He converted from previous activity (driver) because dairy business is more profitable and have stable income.

Generally, all daily expenses can be covered with this activity. He explained that the income from this business is enough but when all the cows are in dry period (not producing milk), it will be difficult situation. Fortunately, a few months after, he will have calves borned and if needed those can be sold to cover expenses during dry period.

2. Land access

Unlike farmers in Lembang area, land access is not a constrains in Ciater area. Farmers can access land of PTPN to be cultivated with napier grass. It depends on them, if they would like to spare more time and energy, they can access more land. Since 2013, one hectare of land can be cultivated with napier grass. Previously, no land available close to his farm so that is why he can access started in last four years.

3. Forage access

If needed, this farmer can find natural grass in tea plantation area. It is still much available but it depends on the distance. In addition, Mr Asep can access paddy straw from paddy farmers surrounding area. He does not need to pay as long as he help paddy farmers to harvest or to do their activity, he can receive paddy straw for free.

He hires worker if needed to help him to cut and to carry grass. Sometimes, it is a bit difficult to hire trustable person who can work correctly because they have their own activity. However, he ask to his brother in his big family and he has someone to help him.

Concentrate feed can be added if the availability of forage is limited. They mentioned that if only change it one or two days, it will be ok for the cattle. The problem is that if they reduce quantity of concentrate, the milk production will be decreased.

4. Waste management

Currently, this farmer use biogas. Biogas was provided by KPSBU via credit scheme during five years. It is easy to get this credit. Waste from biogas are evacuated to his own land to be fertilizer naturally. However, part of them are still evacuated to water ways. He mentioned that there is no problem if do this because the majority of neighbour are dairy farmers. Until now, they do not process it to be organic fertilizer because they have no space to process it.

5. The willingness to maintain dairy farming activity, for the new generation

This family want their children to continue their family business. It is because the business is still interisting. They will receive income from milk selling and calves selling or even from cow selling if needed. The last child now is in SNAKMA (vocational school on livestock). He was expected a lot to be farmers and to enlarge family business.

Monogram

	2007	2008	2012	2013	2014	2015	2016	2017
1. Activities								
dairy farming	Started with three pregnant heifers from project							
2. Workers								
couple	All year in dairy farming							
Hired worker	Part time, only if needed. Particularly to cut and to carry grass							

3. land ownership								
Land access				1 hectare from PTPN				
Land owned	1000 m2							
4. cultivation								
1000 m2	Napier grass							
10000 m2				Napier grass				
5. dairy cattle								
Calves	0	He select good female calves to be replacement stock but sometimes are sold if needed. For male calves are sold at three months old					2	
Heifer	3						0	
Cows	0						5	
Bulls	0						0	

RF011 (Mr Carman, TPK Ciater, Subang District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 1993, Mr Carman started to raise calves to be sold. However, he did not manage dairy cattle to produce milk. Beside this activity, he also worked as a wage worker at PTPN (state tea plantation). Sometimes, he also managed buffalo but only short times. Mr Carman and his family decided to start manage dairy bussiness in 2000. He mentioned that income as wage worker only enough to cover daily expenses but not enough for other expenses such as education. He also explained that in dairy bussiness, he had two benefits, from milk produced and calves borned. The income from dairy bussiness was relatively stable. In other words, as a member of cooperative, he received income every fifteen days and he had no difficulty to access credit from cooperative or neighbour. From this activity he said, his daughter has succesfully graduated from university and he proud of it.

He worked with his wife in dairy farming activity. At the beginning, he had two calves and one lactating cow. For replacement stock, he kept female calf to be lactating cow. If he had three calves for instance, he sold two calves and kept one calf to be lactating cow. Using this strategy, he could add more cows and cover daily expenses. In addition, he also had other cropping activity, i.e paddy. Rice from paddy field was only for family consumption.

For forage feed, this farmer provided 40 kg of natural grass. Eventhough he had more or less 4000 m2 of land cultivated with napier grass and forest tree, he still depended on natural grass that he found in surrounding area. For concentrate feed, he provided more or less 10 kg of concenstrate from cooperative mixed with rice bran from other traders. Sometimes, he added cassava waste.

On average, milk production was more or less 13 liters per cow a day. The income from dairy bussiness was lower than present time. However, compared with other activities that he had previously, he said that dairy bussiness was more profitable. He could purchased land, car, and school's fee from this bussiness.

Recent activity

Nowadays, he had a wife and one daughter. His daughter was already married and moved to Jakarta. She graduated from university and Mr Carman very proud of it because he explained that it was due to dairy bussiness.

He focus on dairy farming activity. He has eight calves, three bulls, eight lactating cows, two heifers and three cows in dry period. Since the beginning, he works with his wife but since three years ago, he hired person to help him in this activity. In addition, he also has land to be cultivated with paddy. The product is mostly for family consumption. Only small part of them will be sold.

Total owned land is more or less 1 hectare. Half of them are cultivated with napier grass and forest tree and the rest are cultivated with paddy.

He provides more or less 5 kg of concentrate purchased from KPSBU mixed with 8 kg of tofu waste. For forage feed, he provides only 5 kg of napier grass mixed with 30 kg of fermented paddy straw. Feeding time is three times a day. Feeding management in rainy season and dry season is similar.

Total milk production a day is more or less 12 liters a day. The monthly income from milk selling is about IDR 4 – 4,5 million. As a member of milk cooperative KPSBU, he receives payment every fifteen days. Milk price depends on milk quality per TPS (milk collecting point). This farm has biodigester to process manure to be biogas. The biogas is usually used for cooking and for electricity. The waste from biodigester is used as fertilizer.

The evolution

Building and the equipment.

The change is that he built the new barn since four years ago. He received it from dairy development project. The capacity of new barn is enough for four cows with ad libitum drink system and the floor is made from porcelain. He mentioned that cows are more comfort with this barn.

Technology

Biogas system with capacity 8 m³ have been installed in last three years. He received it via credit from KPSBU. Every fifteen days, he paid IDR 50 thousands. He was interested to use biogas system because he explained that with this technology he can convert waste to be something useful, i.e. gas for cooking and for electricity and part of them still be useful as fertilizer.

In the future, he plans to have milking machine via credit from KPSBU. However, he has difficulty to pay this credit every fifteen days.

Feeding management.

He changed the type of forage given to the cows. previously, he depended on natural grass. Time by time, he used napier grass. Nowadays, he provides napier grass mixed with fermented paddy straw. He explained that he knew it from training of dairy farming practices. It can save napier grass and can use paddy straw added some nutrient such as salt and others. This kind of feed can keep milk production stability.

Activity of the production

He converted activity generating income from wage worker to dairy farming activity. The reason was that in dairy business, he had two benefits, from milk produced and calves borned. The income from dairy business was relatively stable.

Labor

There is a change regarding the labor. He hired one outside family labour since three years ago. He needs help to manage his farm because the number of cow increased and the age of farmer are relatively old.

Land use

There is change in term of land owned. He purchased land to be cultivated with napier grass, forest tree and paddy. He bought land from selling cows or calves. The reason is that he will need more forage if he add more cows. Eventhough, he can face it by using fermented paddy straw. However, cows still need green fodder for their health and productivity.

Herd size

Since he decided to manage dairy business, he had two calves and one lactating cow. He explained that, if he has three calves, he will sell two calves and keep one calf to be replacement stock. In one side, he needs money to cover daily expenses and costs of dairy business. In other side, he plans to add more cows to have more income. So that is why this strategy was useful to cover those issues.

The limitation

Generally, he does not have any problem regarding land, forage, barn or others. He only mentioned that he has high costs for feed every month and problem of animal health (hypocalcaemia).

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Carman and his wife work together since a long time on dairy business. The main activity generating income is dairy business. They has paddy farming activity. Total production reach 1,5 tonnes a year. However, this activity is mostly for family consumption. Only part of them are sold to others. From this activity they need five or six persons only every harvest time. The reason to do this activity is that to reduce expenses to buy rice. Organic fertilizer from farm is not used for paddy field. They buy urea for fertilizer. In addition, they can use paddy straw to feed the cows.

Eventhough have two activities, they have enough time on dairy business. They hire an outside worker to help them on this activity.

2. *Land access*

In this area, land access is not a main constrain. Farmers can access unplanted land of PTPN (state tea plantation). However, Mr Carman and his wife do not cultivate napier grass on those land. They explained that once they cultivated napier grass, but PTPN want to cultivate other crops. So, they prefer to use owned land. This farmer actually have enough land. They receive about 0,4 hectare of land from parents that are cultivated with napier grass and paddy. Year by year, they purchased land and now total owned land is one hectare. Fifty percent of them are cultivated with napier grass and the rest are cultivated with paddy. On border of paddy field, they also cultivate napier grass.

3. Forage access

In case of lack of forage, natural grass and paddy straw are added. Natural grass can be found in surrounding area. Paddy straw is obtained from their paddy field or is purchased from other village. They mentioned that they use paddy straw to be processed as fermented paddy straw. Mr Carman and his wife can also buy napier grass. Every week they buy napier grass as much as one pick up car. The price is IDR 200 thousands. This farmer go directly to the field to cut and to carry grass after pay those amount. If they difficult to have more forage, concentrate is not added. It is because they can still find forage from other area.

4. Waste management

Mr Carman and his wife manage waste of farm correctly. Manure is processed to be biogas. Other part of waste are used as organic fertilizer. In 2013, they received biogas for free from dairy development project in Ciater (collaboration between KPSBU, private company, and NGO). Until now, biogas still works. This family were chosen to be Demo Farmer. In other words, as a beneficiary, they received renovation of barn, trainings, equipments, and even credit to buy cow.

5. The willingness to maintain dairy farming activity, for the new generation

This family explained that dairy business is a good business. Income from milk selling and calves selling are very interisting. All daily expenses can be covered from this business. Even, they said that from dairy business they can pay all expenses for their daughter to be graduated from university. This business is profitable.

They expected that their daughter can continue dairy business. Eventhough, a daughter who already graduated from university and now live in Jakarta, she can hire worker or apply “shared animal” system on this business. So, she will have passive income from this activity.

Monogram

	1993	2000	2002	....	2014	2015	2016	2017
1. Activities								
Crop farming	All year (paddy) mostly for family consumption and part of them are sold							
Raise calves	Raising and selling calves	Stop activity						
Wage worker	PTPN (state tea plantation)	Stop activity						
Dairy farming		Started with two calves and one lactating cow						
2. Workers								
Couple	All year in crop farming and raising calves	All year in dairy farming						
Husband	Part time as wage worker							
Outside family labor		Hire one worker to help dairy farming activity						
3. land ownership	Small size for house and barn							

Land owned	4000 m2	Purchase land gradually with selling cows or calves						10000 m2
4. cultivation								
4000 m2	Napier grass							
1000 m2	paddy							
4000 m2							paddy	
1000 m2							Napier grass and forest tree	
5. dairy cattle								
Calves		2	If he has three calves, two calves will be sold and one calf will be raised to be lactating cow				8	
Heifer		0					2	
Cows		1					11	
bulls		0					3	

RF073 (Mr Ruslan, TPK Pojok, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Ruslan is a young farmer aged 28 years old. In 2012, He married Mrs Anis and started to have their own dairy bussines with a lactating cow. Before that, he raised his parent's cows with sharing system. In West Java, they call it "Sistem Paro". In other words, he took care of the cows and he received fifty percent from the payment of the milk selling. In addition, he received the first calf borned, and then the second calf belonged to the owner (his parent), and so on for the next calves borned. After married, the calf he had from this system, became a lactating cow. They also bought a heifer in the same year.

Mr Ruslan and his wife foccused only on the dairy farming activity. In their farm, he worked to cut and to carry the grass, to milking, and other heavy activities. His wife only helped him to cleaning the barn and the cows, as well as to feed the cows. They worked together since the beginning of the dairy farming.

They provided around 50 kg of forage (napier grass) per cow a day. Total of land used to cultivate napier grass were 4200 m2 (rented from PERHUTANI) and 1120 m2 (land of his parents). All of those land were used as sources of forage for his cows and his parent's cows. In the dry season, they mixed paddy straw with napier grass for forage feed. They kept the cows in the same barn with his father's cows. The capacity of the barn were five cows.

The milk production was 15-20 liters per cow a day. As a member of milk cooperative (KPSBU), all the milk were delivered to the cooperative. Since became a member, he participated on the training of the good dairy farming practices. Previously, he only learned from his father about the dairy farming practice.

Recent activity

In the family, he has a daughter aged three years old and a wife aged twenty three years old. Recently, this family only foccus on the dairy farming activity. Last year, Mr Ruslan sold all their cows (one lactating cow, one heifer and one calf) to his brother. His family needed money to built the new house. So actually, he has no cows anymore. However, his brother asked him to take care of the cows with the sharing system (Sistem Paro). Normally with this system, the

milk payment and the calves borned will be shared between the owner and the man who take care of the cow. Nevertheless, he received the milk payment every fifteen days only for him. He mentioned that it is because the owner of the cow is his brother so he can negotiate the rules.

Recently, he raises two lactating cows, one pregnant heifer and one female calf in the same barn with two other cows belong to his father. A few months ago, he received a calf from the sharing system but he sold the calf because he needed money to pay the debt. Total of 200 kg of napier grass are distributed to six cows in the barn. In addition, he provides 150 kg of concentrate feed from the cooperative mixed with 160 kg of cassava waste per cow per fifteen days. Sometimes, they add paddy straw for forage feed mostly in the dry season. The quantity of the paddy straw is about 200 kg per six cows per fifteen days.

The total milk production is around 35-40 liters per three cows a day. All the milk are sold to milk cooperative KPSBU. The total income of this activity is around IDR 1,8 million a month. In addition, they could buy a motor cycle and build the house from dairy bussines. The total of land used to cultivate napier grass are the same size with the beginning of the dairy farming activity included 4200 m² of land rented from PERHUTANI and 1120 m² of land owned by his parents.

The waste of this farm are evacuated to the waste pit.

The evolution

Building and the equipment.

Since the beginning (2012), they kept the cows in the same barn with the parent's cows. In the last year, they built the barn close to their house in their parent's land. In the future, they plan to have more cows so they built the new barn.

Feeding management.

The difference of the feeding management compared with the situation at the beginning of the dairy farm bussiness is the quantity of forage and concentrate feed. At the beginning, the quantity of the forage feed was 50 kg per cow a day but nowadays they only provide 33 kg per cow a day. The main reason is the limitation of the forage production. It is because the land to produce forage feed is the same size with before but the number of cows increase. Another limitation is the energy of the worker. Mr Ruslan must find the forage a bit far from his farm so it takes long time and energy. To face this problem, they decide to increase the quantity of the feed concentrate. They were thinking that increasing the quantity of feed concentrate, the milk production will be the same with before.

Activity of the production

Since the beginning, they only focused on the dairy farming activity eventhough the income from this activity is still not enough for them. The main reason is that they have no time to find another job or activities generating income. In addition, if they want to add other farming activity, they have no more land. In the future, they would like to have their own cows so that the income from this activity will increase.

Labor

There is no change regarding the labor. The couple work together all year. The wife help his husband in the barn in particular the lighter activity such as cleaning the barn, cleaning the cows and feeding the cows. The husband has heavier activity such as to cut and to carry the grass, milking the cows, and others.

Land use

Since 2012 until present, the total 4200 m² of land rented from PERHUTANI and 1120 m² of land owned by his parents used to cultivate the napier grass. There is no additional land to cultivate the grass. The alternative is to buy paddy straw or to find natural grass from the surrounding area or other area.

Herd size

Initially, they had one lactating cow and one heifer. Year by year, they gradually had the more number of cow. However, in 2016 they sold all the cows they have to build the new house. In this year, they have one calf from sharing system but they had to sell it to pay the debt. So that, they have no cows nowadays. Even so, they can still raise the cows with he sharing system and they hope they can have their own cows in the future.

The limitation

This family have three limitations to have more cows included waste management, land availability, and money. Increasing the number of cows, will affect the waste management. The forage production from their land is not enough to feed all the cows to have high productivity. Until now, they have difficulty to buy their own cows because they still have debt after they built a new house in 2016.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Currently, this farmer is still focus on dairy business. They spend all time on this business. They expect to get optimal income if foccus. However, nowadays, they have no cattle at all since decided to built a new house. They sold all cows (two calves, one heifer and one lactating cow) to the brother but they can still raises those cows. The income will be shared together. It is like family aggreement which means that there was no rigid rules about the milk selling or calves selling. They can discuss together.

In other side, this farmer expect that his wife can have other activity generating income. It is to have more income and can cover daily expenses. Nevertheless, she has to focus on to take care the family and to help her husband on light activity on dairy farming. Therefore, she has no time available for other activity. Mr Ruslan said, the daily needs can be covered from this dairy business if they have 5-6 lactating cows. So that, they do not need to add more activity.

2. *Land access*

This farmer has a constrain in term of land access. Fortunately, he can access land of PERHUTANI to be cultivated with napier grass. Since 2012 until present, the total 4200 m² of land rented from PERHUTANI and 1120 m² of land owned by his parents are cultivated with napier grass. Every fifteen days, cost of land rented will be directly deducted by KPSBU. Eventhough, number of cows are increase but there is no additional land to cultivate grass. So that, he has to find solution to cover animal needs.

3. *Forage access*

Forage is relatively difficult to be accessed. It is because the infrastructure to go there such as road is not good enough even a bit dangerous. They cannot take motorcycle. In addition, the distance is also far from farm. It takes time and energy. So, at the moment, this farmer decides to focus on adding concentrate feed to cover animal needs.

Sometimes, Mr Ruslan also add paddy straw from surrounding area and from Subang District particularly in the dry season.

They understood, that it is not good to increase quantity of concentrate. It is because cost of concentrate feed is expensive. The monthly income will be decreased. In addition, they mentioned that forage feed is better to increase productivity of cows. Therefore, if they have any cheaper and easier access to obtain forage, they will focus on forage more than concentrate.

4. *Waste management*

Mr Ruslan evacuates waste of farm to the waterways or surrounding area. From our observation, this waste sometimes cause pollution of smell. However, there are many dairy farmers in surrounding area so that it is not real problem for them.

Installation of biogas actually is accessible for farmers who are member of cooperative KPSBU. They pay only IDR 100 thousands per month to install it. However, this farmer does not apply this technology due to the barn actually is owned by his parent. He has no right to have it in this barn.

5. *The willingness to maintain dairy farming activity, for the new generation*

Dairy business is a good business. If farmer has at least five or six lactating cows, the income from this activity (from milk selling) can cover daily expenses. However, if the number of cows are less than that, some additional income will be needed, it depends on how much their monthly espenses. Farmers still have income from calves selling or cows selling if needed.

Mr Ruslan expected that his child will continue dairy business. He mentioned that this business is still interisting. He can now build a new house and purchased things from this activity.

Monogram

	2012	2013	2014	2015	2016	2017
1. Activities						
Dairy farming	Dairy farming					
2. Workers						
couple	All year					
3. land ownership (date of acquisition)	1120 m2 (land of his parents)					
Land rented	4200 m2 (PERHUTANI)					
4. cultivation						
5320 m2	Napier grass					
5. dairy cattle						
Calves					1 (Sold)	1 (have been sold)
Heifer	1				1 (sold)	1 (shared animal)
Cows	1				1 (sold)	3 (shared animal)

GD003 (Mr Emo, TPK Ciater, Bandung Barat District)**FIRST INTERVIEW****The beginning of dairy farming activity**

Mr Emo started dairy farming activity in 2007. Previously, he raised beef cattle, sheep and buffalo. He explained that he did not receive daily income from this activity, in other side he had an opportunity to be dairy farmers since dairy development project opened in Ciater area. He received three pregnant heifers via credit from this project in collaboration between private company (Danone) and milk cooperative (KPSBU). Unfortunately, one out of three cows he received, had health problem. He had to slaughter this cow. He mentioned, he also had cow with problem with reproduction, consequently he had to sell this cow.

Beside dairy farming activity, this family cultivated banana and cassava and produced chips from those ingredients. Mr Emo worked in these two activities. Sometimes, his children help him to manage dairy farm. His wife focussed on processing banana and cassava crackers.

Since beginning, they had 20840 m² of land access included 840 m² of owned land to be cultivated with napier grass; one hectare of neighbour land to be cultivated with napier grass, banana and cassava; and more or less one hectare of land access to PTPN (State Tea Plantation) to be cultivated with napier grass. Mr Emo explained that there was no difficulty to access land of PTPN, if he had willingness to find it and to cultivate it. Mostly, farmers in this area cultivate napier grass at unused land of PTPN. Eventhough, it seems like illegal but when farmers discussed with staff of PTPT, farmers could use this land as long as it did not disturb tea plantation.

This farmers provided 200 kg of concentrate per cow a month. In addition, they gave 40-50 kg of forage which are mostly napier grass mixed with natural grass. In the beginning, milk production per cow a day was only seven liters of milk. He explained that he had no experience on dairy practices before. In addition, the cows had different environment. The cows came from Baturaden where they had grazing system, but in Ciater area, they must keep the cows in barn every time. All milk were delivered to milk cooperative KPSBU. He mentioned that income from milk selling was only IDR 1 million a month.

Recent activity

In the family, there are five persons, including couple and three children. One child has married, another child moved to Bandung for working and last child stays with parents. Until now, they still have two activities generating income including dairy farming activity and crop farming with processed product. For dairy farming, they have one worker who work all year and one worker who spend sometimes on this activity. For crop farming and processed product, they also have two workers but mostly his wife who focuses on this activity.

They have one lactating cow, a bull and a female calf. Normally, they keep female calf to be replace stock but it will be sold when they need money. After three months old, they sell male calf but recently they would like to keep male calf until "Idul Adha" (a holiday for muslim) because the price will be higher.

This family have 840 m² of own land. In addition, they have access more or less one hectare to be planted with napier grass. They also have one hectare to be managed, belongs to a family who lives in Jakarta. Mr Emo mentioned that he can use this land for free to be cultivated with

napier grass, banana, cassava and others because he knows well and have good relationship with the owner.

This farmer provides 5 kg of concentrate and more or less 50 kg of forage (mostly napier grass mixed with natural grass) per cow a day. He mentioned that quantity of forage has to be fit with cows needs, for instance a cow will need forage which amount as 10% of body weight. He received this info from training about dairy farming practices held by cooperative, government and NGO. He does not add other feeds such as cassava waste or tofu waste because the cost will be higher and he will receive less income.

Milk production is 10 liters a day from a lactating cow. Like others, all milk are delivered to milk cooperative KPSBU. Total income from milk selling is about IDR 1-2 million a month. In addition, they receive IDR 1-1,5 million from crop farming and processed product.

The evolution

Building and the equipment

This farmers built a new barn. Initially, barn is only enough for two cows but now capacity of barn is enough for four cows. In the last three years, barn was renovated by dairy development project. Feed bunk are made from ceramic and lower than before. It make them easier to cleaning barn.

Biodigester was installed since three years ago. It was provided by KPSBU via credit scheme.

Feeding management

The quantity of forage and concentrate are relatively similar with before. He explained that before starting dairy business, he received training from cooperative about dairy farming practices. Theoretically, he already had know-how capital to be dairy farmer.

Activity of the production

Activity of production has changed. Previously, this family had beef cattle, sheep and buffalo. Since, dairy project was opened in Ciater area (in 2007), he started to be dairy farmers. Routine income and more profitable business was main reason why he converted his activity. In addition, this family still continue crop farming activity.

Labor

Main worker is a husband. However, since few times ago, his child helped him on dairy business. This family do not need any outside worker to help them because their business scale is still small.

Land use

Generally, there is no change in term of land access. Since beginning, they access 2 hectares and 840 m² of land that are cultivated with mostly napier grass, cassava, and banana. Land of PTPN are accessible for farmers in this area.

Herd size

Initially, three pregnant heifer were provided via credit scheme of dairy development project. However, one cow was dead when just arrived at barn. Unfortunately, this farmer must pay reimbursment of credit for total cattle received. Usually, every female calves borned are selected to be replacement stock and male calves are also raised until one year. Those calves are sold or replaced with heifer or lactating cow.

The limitation

To add more cows, the difficulty is only availability of money to buy a new cow. It can be done only via credit scheme.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Emo and his family has two activities generating income including dairy business and crop farming activity. Dairy business started in 2007 when milk cooperative (KPSBU) collaborate with private company extended their business in Ciater area. Previously, they had beef cattle, sheep, and buffalo to be raised. However, they decided to convert to be dairy farmers because they need daily income to cover daily expenses. They received mid-monthly income from milk selling. Meanwhile, from previous activity, he only received money every three months or more.

This family also cultivate banana and cassava. They make banana chips and cassava chips and then sell it to direct consumers who are mostly their neighbour. The main reason having two activities is to increase family income. In addition, there are synergy between those activities. Waste of dairy farm are used to be organic fertilizer for crop land and biogas for cooking. It can reduce cost of making chips. Meanwhile, banana trunk and cassava sometimes can be used to feed the cows. Cows and calves are also useful for saving as well.

2. *Land access*

Farmers in Ciater area can access land of PTPN to be cultivated with napier grass. Therefore, land access is not a main problem for them. This farmer (Mr Emo and his family) access one hectare of land of PTPN, one hectare of land owned by neighbour who lives in Jakarta, and 840 m² owned land. The important things to have those land are money to buy land, good relationship with the owner (then after they trust this farmer), and willingness to find forage in the area which is far from farm.

3. *Forage access*

Mr Emo can provide enough grass to his cows from land access. However, sometimes he also find natural grass from surrounding area and land of PTPN. Natural grass is still available but many farmers compete to obtain it. This farmers actually does not need to buy grass from others because he has big land to access forage and only has small number cattle. In addition, outside worker is not needed because he still has time to manage all by himself.

Mr Emo explained that in case of limited forage, he won't to add more concentrate because feed cost will be too expensive and cow will be easy to paralyze after three times of calving. He said that balance between forage and concentrate should be well managed to increase productivity and efficiency.

4. *Waste management*

In term of waste management, Mr Emo apply good practices. He explained that he received those practices from extension and training. He installed biodigester through credit scheme of KPSBU. Every fifteen days, he has to pay IDR 50 thousands and it is directly deducted from milk payment. Manure are processed to be biogas. Biogas are very useful for cooking and can reduce daily expenses or even cost to make banana and

cassava chips. Residu from biogas are evacuated to crop land. It is useful as organic fertilizer.

5. *The willingness to maintain dairy farming activity, for the new generation*

Their child often help them on dairy farming activities. Mr Emo also want his child to continue his family business. Eventhough, he only has one lactating cow at the moment, dairy business is still interisting business. Farmers can receive income from milk selling every fifteen days from cooperative. Generally, he can cover daily needs from this activity. In addition, calves can be saving and they can sell it if needed. Mr Emo was inspired by success dairy farmers in Lembang. Those farmers have good income from this business.

Monogram

	2007	2008	2009	....	2014	2015	2016	2017
1. Activities								
Dairy business	Started with purchasing three cows via credit scheme							
Crop farming	Banana and cassava. The products are processed to be chips							
2. Workers								
Husband	All year in dairy business							
Child					Part time			
3. land ownership	Small size for house							
Land owned	840 m2							
Land access to PTPN	10000 m2							
Land access to neighbour	10000 m2							
4. cultivation								
15840 m2	Napier grass							
5000 m2	Banana and cassava							
5. dairy cattle								
Calves	0	Female calves are selected to be replacement stock. Male calves are kept until more or less one year to be sold or replaced with a cow. Those calves are sold as well if needed.						1
Heifer	3							0
Cows	0							1
bulls	0							1

PS010 (Mr Yudiana bin Uju, TPK Gunung Putri, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Yudiana started dairy farming activity in 1994. Initially, he helped his father on this dairy business. A year after, he started his own dairy farm with a dairy cow and a heifer through shared animal from his parent. In Indonesia, particularly in West Java, “shared animal” is also known as “Sistem Paro”. In others words, farmers raise dairy cow, and they will receive milk selling and calves born (normally 50 : 50 which means that first calf born will belong to farmer and the second will be owned by owner). Since beginning he also had additional activity generating income such as crop farming (broccoli and tomato).

At the beginning, one dairy cow and one heifer he raised. He selected a good female calf to be replacement stock. Usually, male calf is sold. To feed the cows, he provided mostly natural grass and concentrate. Natural grass was obtained from surrounding area, or even outside the hamlett. Availability of natural grass was relatively more than nowadays. At that time, farmers did not cultivate napier grass on PERHUTANI (state forestry) because there was no collaboration between KPSBU (milk cooperative in West Java) and PERHUTANI. So, farmers really depended on natural grass, and might be some depended on their own land. For concentrate, he purchased from milk cooperative KPSBU.

On average, milk production reached 25 liters per cow a day. He explained that cows were good genetically. In addition, concentrate feed had good quality. Availability and good quality of raw material were main reason to make a good quality concentrate. As a member of cooperative, all milk are sold to cooperative.

Recent activity

In the family, there are three persons including his wife, his child and him. His child is now in primary school. His wife helps him on the activities generating income. This family has two main activities, including dairy farming and crop farming.

On dairy farming activities, total population of cow is two lactating cows and one heifer. The calves borned will be raised (particularly female calves) after His wife helps him to clean barn, to clean cows and to feed cows. Meanwhile, Mr Yudiana do heavier activities such as to cut and to carry grass, as well as to milking cows. On crop farming activity, this family cultivate broccoli, tomatoes and cabbage.

Total 5600 m² land accessed to cultivate napier grass. This land owned by PERHUTANI. In addition, 840 m² of land owned by his father and 1400 m² of land rented, are cultivated broccoli, tomatoes and cabbage. He pays IDR 5 million a year for a land rented. The difficulty is that land of PERHUTANI will be no longer accessible.

Quantity of forage provided to cows is about 70 kg per cow a day. This amount is for dry season and relatively higher than other farmers. In the dry season, quantity of forage is lower and sometimes he add paddy straw. In addition, total 4-5 kg of concentrate and 2-3 kg of cassava waste are given to a cow a day.

Milk production a day is about 25-27 liters per two lactating cows. As other dairy farmers in surrounding area, all milk are delivered to KPSBU. Farmer will receive payment every month. Total income from dairy business (in particular milk selling) is about IDR 2 million a month. In addition, this farmer obtain IDR 3-4 million per three months from crop farming. It depends on market price.

The evolution

Building and the equipment.

There was no big change at barn. He mentioned that normally this barn should be renovated soon because the material is already obsolete. However, he needs much money to do it, so he is still waiting.

Technology

Biodigester was installed in this farm since a year ago. KPSBU provided such credit to install biogas system. Manure from farm is expected could be processed as useful product. This farmer use biogas for cooking. The rest will be used as organic fertilizer.

Feeding management.

Natural grass have been converted with napier grass. Previously, he depend on natural grass from surrounding area but since farmers have access to land available at PERHUTANI, he started to cultivate napier grass.

Activity of the production

Since beginning, he already has two activities generating income including dairy farming and crop farming. Those two activities are important to his family. He explained that 70 percent of income come from dairy business and the rest is from crop farming activity.

Labor

There is no change in term of labor. The couple (wife and husband) are always together for their activity generating income. However, sometimes when they hire someone to help them on dairy business (particularly to cut and to carry grass).

Land use

At the beginning, he could not access land from PERHUTANI but now the land is accessible and it can be cultivated with napier grass. In the future, it is an issue about land access because PERHUTANI will probably convert this land to be tourism place.

Herd size

He has three cattle (including two lactating cows and a heifer). Certainly, there is a change in term of population of cow. However, four cows will be enough for this family due to the capacity on dairy farming activity (barn, workers, land access, others.)

The limitation

The limitations of this farm are:

- a. capacity and quality of barn. Some materials used at this barn is mouldy. It should be renovated in a few coming month.
- b. Forage access. It is still enough but in the dry season, paddy straw should be added.
- c. Land access. As long as PERHUTANI land is accessible for farmers, it will be enough to feed the cows. However, if PERHUTANI will convert this land, it will be difficult for him and for farmers in this area to cultivate napier grass.

SECOND INTERVIEW

1. Diversity of activity

Mr Yudiana has two activities generating income including dairy farming and crop farming activity. Three reasons he explained for doing those activities:

- a. He loves those activities and he gets bored if only do one activity. It seems like refreshing from one activity to another activity.
- b. Better income. Income from dairy business is better and stable. Every month, farmer receives payment of milk selling from cooperative. However, if only depend on this activity, he cannot cover all daily expenses. Every months, he needs IDR 3-4 million for daily needs and income from milk selling per month is only IDR 2 million. In other words, he needs both activities.

Crop farming	Broccoli, tomatoes and cabbage						
Dairy farming	Started to dairy farming with help his parent	Started his own dairy business with shared animal from parent (1 cow and 1 heifer)					
2. Workers							
couple		All year in dairy farming and crop farming					
husband	Part time in dairy farming						
Outside family labor		Hired outside family worker if needed to help cutting and carrying grass					
3. land ownership	Small size for house and barn						
Land owned	840 m2 owned by his parent						
Land rented		5600 m2 PERHUTANI + 1400 m2					
4. cultivation							
5600 m2		Napier grass					
840 m2	Broccoli, tomatoes, and cabbage						
1400 m2		Broccoli, tomatoes, and cabbage					
5. dairy cattle							
Calves		0	He select good female calves to be replacement stock but sometimes are sold if needed				0
Heifer		1	2				1
Cows		1	0				2
bulls		0	0				0

RF074 (Mr Toni, Lembang, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

Mr Toni already helped his parent's dairy business since he was in the primary school. In 2016, he married and he started his own dairy business. In the beginning, he had shared animals with his parents. In West Java, we call it "Sistem Paro". In other words, he had received fifty percent of the income of the milk selling and calves borned. He raised a calf from this system to become a lactating cow. After calving, this lactating cow had a health problem so he decided to sell it with the low price (IDR 4 million). He then raised the calf borned from this cow. He usually raise the female calf and sell the male calf aged seven months. About two years ago, he purchased a pregnant heifer then he raised this heifer to become a lactating cow. Unfortunately, after calving, the lactating cow was paralyzed (hypocalcaemia) then he sold this cow and the calf as much as IDR 14 million.

He had more or less 5000 m2 of land to cultivate napier grass. He rented about 4200 m2 of land in the forest from collaboration between milk cooperative (KPSBU) and PERHUTANI. He provided around 60 kg of napier grass per two cows a day. He also mixed 13 kg of concentrate feed with 10 kg of cassava waste, some brewers grains and tofu waste. The feed management in the dry and rainy season was similar. Eventhough, in the dry season, sometimes the forage production was not as much as in the rainy season. The cultivation of the napier grass was still enough to cover the cows need.

The waste from this farm directly evacuated to the river because there was no place to put or to process the manure.

Beside the dairy farming activity, he also had two other activities included crop farming and trading of avocados. He rented 2100 m² of land to cultivate broccoli. Those two activities were helped by his wife. He mentioned that the income from those activities were good to cover the daily expenses.

Recent activity

He has two children (6 months old and 11 years old) and a wife. Nowadays, he still has three activities generating income included dairy farming, crop farming (broccoli), and trading (banana).

Recently, he only raises one cow in the dry period. Before the dry period, the milk production per cow a day was 30 liters. This amount is higher than the average on surrounding area. As a member of milk cooperative KPSBU, all milk produced were directly sold to this cooperative. He provides more or less 50 kg of napier grass per cow a day. He also gives 13 kg of concentrate from milk cooperative and 10 kg of cassava waste per cow a day. The quantity of concentrate and cassava waste.

The total land used to cultivate napier grass is 9200 m² included 5000 m² of owned land and 4200 rented from PERHUTANI. The payment is directly deducted by KPSBU from the milk selling every fifteen days. In local name, they call it "sharing rumput". In addition, he also rent 2100 m² of land to cultivate broccoli. He pay IDR 3 million per year.

The total income from dairy bussiness is around IDR 1 million per month. The total income from crop farming (broccoli) in the last three months were IDR 2,7 million. It depends on the market price. In the last three months, the price was too low so the income from this activity was low. The most interisting income is generated from trading of banana. He mentioned that the gross income from this activity is around IDR 6 million.

The evolution

Building and the equipment.

There is no different between present time and in the past regarding the building and the equipment of dairy farm.

Feeding management.

There is the change regarding the feeding management. He mentioned that nowadays the quality of the concentrate is better. The quantity of the forage feed today is higher than in the past. It is because the number of the cow is lower meanwhile the forage production is the same quantity. For instance, in the past, he provided 30 kg per cow a day but now he can give 50 kg of napier grass per cow a day. In the future if he increases the number of cow, the quantity of the forage feed will be lower. It might be a reason why the milk production of his cow relatively high. Other difference is about the use of the brewer grains and tofu waste. He does not provide those two feeds material anymore because he was thinking that there is no big effect in term of milk production meanwhile the feed cost is higher.

Activity of the production

Since the beginning, this family has three activities generating income. However, he changed trading of avocados to banana because the market and the income is better. The main reasons

why he has three activities are that he would like to use his available time to the useful activities. In addition, he could not depend only on the dairy farming or crop farming because the uncertainty of the income. He needs money to cover all daily expenses.

Labor

There is no change regarding the labor. Since the beginning, he works alone on the dairy farming. The couple work together on two other activities (crop farming and trading). The wife help him to sell the bananas and to cultivate the broccoli.

Land use

There is no evolution regarding the land ownership or land rented. Since the beginning, he had 9200 m² of land to be cultivated with napier grass. Meanwhile, he rented 2100 m² of land to cultivate broccoli. He mentioned that there is the different price between now and in the past. But he did not change the size of land rented.

Herd size

Initially, he only had a calf from the shared animal system (sistem paro) with his parents. Gradually, he had more cows and he also sold the cows particularly the male calf. Female calf were kept in the barn to be a lactating cow. At least, there were two lactating cows had been sold due to health problem. Eventhough, nowadays he only has one cow, in the future he plans to have three more cows. Because he was thinking that he has enough forage from the land to feed the cows. When it is not enough, he still can look for the natural grass in the forest or surrounding area. He also was thinking that when he has four cows he expect the income will be increase. In addition, it will make him safe regarding the income if there is a cow in the dry period. If he only has one cow, it will be difficult when the cow in the dry period. He cannot receive the money from this activity. In a few coming months, he will buy a cow helped by credit with zero interest from KPSBU.

The limitation

He did not mention any problem today. But in the future he does not know what happen if the collaboration between KPSBU and PERHUTANI to use land in the forest will be stopped. In addition, the uncertainty of the land rented will be a problem because most of the land used for his activities are coming from the land rented.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Toni and his family has three activities generating income icnluding dairy business, crop farming (broccoli) and trading banana. Nowadays, trading banana is a main activity to cover daily needs. It is because he has no lactating cow currently. Usually, monthly income from dairy business is more or less IDR 1 million. Meanwhile, gross income from trading banana is six times higher. The reason to have more than one activity is to secure family income to cover daily expenses in particularly when no cows producing milk (cows in the dry period). In addition, they can use available time to have useful activities. Dairy business is also only for saving because number of cattle is only one cow. However, there is no synergy between those activities.

2. *Land access*

Majority of dairy farmers in Lembang area has difficulty to access land. However, Mr Toni has total 5000 m² of owned land. He also access 4200 m² of land of PERHUTANI to cultivate napier grass. Some farmers can access those land because they live close to

those land. In addition, total 2100 m² of land rented to cultivate broccoli. To rent land in this area, availability of money is important as well as good relationship with land owner. From other activities, Mr Toni has money to access those land (rent or even buy it).

3. *Forage access*

Mr Toni does not depend only on napier grass from land access to feed the cows. He also provide forage from natural grass that he find from surrounding area and forest or even in Subang District. However, he does not use paddy straw eventhough in the dry season. It is because the availability of forage is still enough to feed only one cow. Adding more worker from outside is not needed. He can cut and carry forage by himself.

4. *Waste management*

Mr Toni evacuate waste of dairy farm to the waterways. He mentioned that no body protest about his action. He said, in the waterways crop farmers take those waste to be organic fertilizer. Actually, cooperative provide biodigester to all dairy farmers through credit scheme. Farmers only pay IDR 100 thousands a month. However, this farmer has no space available in barn to install it or to transform waste to be organic fertilizer.

5. *The willingness to maintain dairy farming activity, for the new generation*

Eventhough, dairy farmer is not main business, this business is still interesting. He uses dairy business for saving. Sometimes, when he needs much money (school fee for children, wedding party, or others) he can sell calves or cows. In addition, income from milk selling can help to cover daily expenses. So that is why he expected his children can continue dairy business.

Monogram

	2006	2007	2008	2009	....	2015	2016	2017
1. Activities								
Crop farming	Broccoli							
Trading	Avocado					banana		
Dairy farming	Dairy farming							
2. Workers								
Couple	All year in crop farming and trading							
husband	All year dairy farming							
3. land ownership (date of acquisition)	5000 m ²							
Land rented	6300 m ²							
4. cultivation								
9200 m ²	Napier grass							
2100 m ²	Broccoli							
5. dairy cattle								
Calves	1		1	1			1 have been sold	0
Heifer		1				1 (buy)		0

Cows			1 (dead)	0		2	1 and 1 have been sold	1
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PS015 (Mrs Santi, TPK Gunung Putri, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 2001, Mrs Santi and her husband started dairy farming activity. After married in 1999, the activity generating income were only from crop farming such as lettuce and chili. They decided to start dairy business because they were thinking that they would have income routinely from this activity. The payment from milk cooperative (KPSBU) is every fifteen days. In addition, another reason was that they get the income from cultivate vegetable is only every three months meanwhile they need money for daily needs.

At the beginning, they bought a pregnant heifer with the price was IDR 6 million. Then, they raised the cows to be lactating cows until now. The female calves would be a replacement stock (they kept it to be a lactating cow) and the male calves would be sold aged three months old. She learned the dairy farming practices from the father of his husband. The family of her husband is dairy farmer since a long time. Her husband also helped his father to raise the dairy cows so he had experience in dairy. Since became a member of KPSBU (in 2004), her husband received some training in the dairy farming practices. In 2002-2004, they were a candidate of a member. Initially, the workers of this farm was only her and her husband. They rented land for the barn of their cows.

The milk production of this farm at the beginning was around 10-15 liters a day. As a member of KPSBU, the milk directly goes to this cooperative every morning and afternoon. Napier grass was cultivated on land rented (about 1400 m²) to feed their cows. They also added the natural grass from surrounding area for their cows. The cows received around 40 kg of fodder per cow a day. For concentrate feed, they gave 4 kg concentrate feed from KPSBU and around 4 kg of cassava waste per cow a day. Similar with others, the cost for concentrate feed was directly deducted from his payment of milk sold every 15 days. The feeding management of this farm was same in the dry and the rainy season.

Recent activity

She has a husband and three children aged seventeen, ten, and five years old.

At present time, they have three activities to generate income included crop land, wage worker and also dairy bussiness. The family continue to cultivate the vegetable (lettuce and chili) and since last year they started to cultivate fruit (ananas). Her husband also become a wage worker, keeping his neighbour land. In the dairy activity, they have two lactating cows, one pregnant heifer and one female calf. The milk production is around 30 liter a day from two lactating cows. The total workers of this farm are three persons, included her, her husband and outside family labor. They hire a man to help them in dairy farming activity because mostly they have do not have enough time for three activities generating income. In a month, an outside family labor works for around 20 days (depend on their time). She foccus on the cleaning barn and cows. Her husband works to cut and to carry the grass, and milking. An outside labor help them to cut and to carry the grass and also to milking. The expense is around IDR 300 thousands a month for the labor.

Since the beginning until now, they usually sell the male calf after 2-3 months old, and they raise female calf to be a lactating cows (replacement stock). The replacement stock depend

only on the female calf. In other words, he never buy a lactating cow or heifer for their farm. They have around 4000 m² of land from parents (it still belongs to their parent) and all of them are cultivated with vegetable and fruit. Meanwhile, they rent 1400 m² of land from the neighbour (pay as much as IDR 1 million a month) and 1 hectare of land from the collaboration between KPSBU with PERHUTANI (for the payment, it will be deducted directly from KPSBU every fifteen days) to be cultivated with napier grass.

The waste from this farm are delivered to the crop land as fertilizer.

Since last year they added paddy straw to feed the animal. They gives more than 40 kg of forage (napier grass), 2 kg of paddy straw, 4 kg of concentrate feed, 4 kg of cassava waste for a cow a day. This farm provide more forage than concentrate. They reason is that to reduce the cost and to have better income. They purchase concentrate feed from KPSBU. In the dry season and the rainy season, they mix nappier grass with paddy straw to feed the cows because he has not enough forage. They purchase paddy straw and will be delivered to their house so they do not need to find the paddy straw from other region like other farmers. They have ever received the subsidy of concentrate feed for a few months from the local government but not anymore.

The monthly dairy income after deducted by feed costs and other expenses (January 2017) from milk cooperative was around IDR 600 thousands. The income from other farming activity (vegetable and fruit) is around IDR 8 million per three months. In addition, the income from wage worker is IDR 1 million a month. In the last year, the income from crop land was higher than two other activities.

The evolution

Building and the equipment

At the beginning (2001), they rented land from the neighbour for the barn of the cows but since last year they built a new barn in their land (behind their house). Previously, they changed the material used for roof (from tiled roof to asbestos) and floor (from soil and wood to concrete). They constucted a new barn because the land that they rented for previous barn has been sold to other so that they could not rent anymore.

Feeding management

The difference of the feeding management compared with the situation at the beginning the dairy farm bussiness is the use of paddy straw since 2016. The main reason is the limitation of the forage production on land rented. Since beginning, this farm more focus on the use of forage instead of concentrate feed to have better income from this dairy bussiness.

Activity of the production

Initially, the activity was specialized in horticulture but after they decided to have other activities generating income (diversified). The main reason is that they would like to have better and routine income to cover their daily expenses. The uncertainty of price of the agricultural product and the income every three months became also their consideration to diversify their activity. In the last year, the horticulture generated more income than two other activities.

Labor

Since they diversified their activities generating income, they needed to hire a man to help them manage their dairy bussiness. This option has been chosen because sometimes they did not have enough time to manage the dairy activity. A a wage worker, the husband has a limitation regarding time availability and the energy. The wife mostly foccus on the horticulture so she did not has so much time available.

Land use

Nowadays, they rent a total of 11400 m² included 1400 m² from the neighbour and one hectare from the collaboration of KPSBU with PERHUTANI in the forest to be cultivated with napier grass. In 2016, they bought a total of 2800 m² of land in Subang Regency to be cultivated with ananas and vegetable.

Herd size

Initially, he only had a pregnant heifer. Year by year, they gradually had the increase number of cow. However, the number of the cows is still not many because they sold the calves particularly a male calf. Nowadays, they have three cows and one female calf.

The limitation

Waste and land availability. If they would like to increase the number of cows, they difficult to evacuate the waste of the farm. The limitation of the land availability make them difficult to provide enough forage to the cows. It will decrease the productivity of cows.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mrs Santi and her husband have some activities generating income including dairy business, crop farming, wage worker, and worm farming. After married, the activity was crop farming during one or two years. Then, they decided to be dairy farmer to have routine income. However, crop farming activity restarted in 2010 after their dairy business was well established.

For dairy business, they can hire outside worker to help them on milking cows and sometimes cutting grass. A husband spend time on crop farming and dairy farming. In addition, a husband work as wage worker to guard neighbour's land. This activity does not take time. When discussion with this farmers, they also mentioned that they have worm farming. This activity actually have been conducted since more than ten years, together with dairy business. The income from this activity is about IDR 1,5 million a month.

The reason why they have some activities is to increase and to secure family income. Usually, dairy business is a main activity (60% of family income). However, at the time we interviewed, the cow was in the dry period so dairy business only contributed less than 50 % of family income.

Another reason is that there is synergy between one activity and others. For instance, dairy farm produce manure. Those manure are used to be organic fertilizer for crop land and also to be used as media for worm to grow (for worm farming). This farmer can reduce cost of fertilizer by using organic fertilizer, eventhough they still need to buy chemical fertilizer (NPK, urea, TSP). Agricultural by-product from crop business can be used to feed the cows.

Limited capital to add more cows (space in barn, land access for forage production, and workers) become a reason. Since they only have less than four cows, other activities generating income can be interesting to do. They mentioned that if they have more cows in the future, probably they only focus on dairy farming activity. This activity will take

time if they do not hire additional outside worker or conduct “sistem paro” (shared animal).

2. *Land access*

Majority of dairy farmers in Lembang difficult to access land. However, this farmer can access more or less 1,14 hectares to be cultivated with napier grass including one hectare of land of PERHUTANI and 1400 m² rented from neighbour. This farmer can access land of PERHUTANI because they live close to those land (land in the forest which is managed by PERHUTANI) and also have money to pay it every fifteen days via cooperative. Even so, location of those land is relatively far from farm and sometimes it is difficult to cut and to bring it from forest to the farm. So, they more depend on land rented from neighbour. Main constraint for farmers in this area is if PERHUTANI in the future want to convert those land to be tourism place. Farmers will have to find another solution to produce forage.

In addition, total 6800 m² of land including owned land and land owned by their parent are cultivated with vegetables and fruits. They can buy plot of land from cows and calves selling.

3. *Forage access*

Mostly, this farmer provide napier grass from land access. However, since last year, they also add paddy straw to feed the cows because of limited forage from land access. Paddy straw can be ordered and delivered to their farm. In addition, this farmer sometimes provide agriculture by-product (corn leaves, cabbage leaves, and others) which are obtained by their crop land or purchased from other crop farmers.

4. *Waste management*

Mrs Santi and her husband do not install biogas to process manure to be biogas. Eventhough, it is easy to obtain this technology from cooperative via credit scheme, they have no space to install it in barn. All waste are useful. Part of them are evacuated to crop land to be organic fertilizer. Other part are used as media to grow for worm.

5. *The willingness to maintain dairy farming activity, for the new generation*

Nowadays, dairy business is still main activity generating income. Routine income every fifteen days from milk selling to cooperative will be received by farmers. Calves and cows selling are mainly for saving or to cover big expenses. So that is why dairy business is interesting to them. However, they do not want their children to continue this business. This business is tiring activity, need energy and time, and in the future they will face the uncertainty of land access from PERHUTANI. In other side, they want their children to continue study at university, work at the office or other job which meet the desires.

Monogram

	1999	2000	2001	2002	....	2010	2013	2014	2015	2016	2017
1. Activities											
Crop land	Vegetable (lettuce and chili)					Vegetable (lettuce and chilli)				Vegetable (lettuce and chili) + fruit (anasas)	

Dairy business	Dairy farming									
Worm farming	Worm farming									
Wage worker	As a guardian to keep neighbour's land									
2. Workers										
Outside family labour	1 person (about 20 days a month)									
Couple	All year									
3. land ownership (date of acquisition)	4000 m2 land of their parent								4000 m2+ (bought 2800 m2 in Subang)	
Land rented	1 hectare (PERHUTANI) + 1400 m2 (neighbour)									
4. cultivation										
4000 m2	Vegetable (chili and lettuce)									
2800 m2									Fruit (anasas) and vegetable (chili and lettuce)	
11400 m2	Napier grass									
5. dairy cattle										
Calves			0	1	Female calves are selected to be replacement stock (but some others are sold if needed) and male calves are usually sold.					1
Heifer			1	0						1
Cows			0	1						2

GD078 (Mr Arun, TPK Bukanegara, Bandung Barat District)

FIRST INTERVIEW

The beginning of dairy farming activity

In 1994, Mr Arun married with his wife. After married, he had two activities generating income included crop farming (chili, tomatoes and other vegetable) and rent a horse for tourism. He rent a horse as an activity generating income were between 1994 to 2001. He then decided to sell the horse and changed the activity to become a wage worker for two years. In 2003, he started dairy farming activity. Initially, he bought one heifer. The dairy farmers in surrounding area inspired him to start this activity. At that time, he had two activities included crop farming

and dairy farming. Since 1994, he continued crop farming even though another activity has changed. The couple and sometimes helped by labour outside family worked together in crop farming.

The couple work together in dairy farming activity. He kept the female calves to be lactating cows but usually sold the male calves and save the money to buy a new cow. He also sold the cows when he needed money.

He provided 10 kg of concentrate per cow a day, some tofu waste, some brewers grains and more or less 45-50 kg of forage per cow a day. The maximum milk production was 25 liters per cow a day.

The size of land rented was 4200 m² that have been planted with vegetable (chili and tomatoes) and napier grass. Only small size of land that have been planted with napier grass.

Recent activity

In the family, he has a daughter (already married), a son aged thirteen years old and a wife. Until now, his wife always help him on the activities generating income included dairy farming and crop farming. They have three lactating cows which produce total 35 liters of milk a day. The quantity of forage to feed the cow is more or less 50 kg per cow a day. In addition, they provide around 6 to 7 kg of feed concentrate which is purchased from milk cooperative KPSBU and 10-11 kg of cassava waste per cow a day. They no longer use tofu waste and brewers grain to feed the cows. In the dry season, they have same feed management. They do not give paddy straw to the cows.

They have only small land for house and barn. A total of 3500 m² of land are rented to be cultivated mostly with vegetable (chili and tomatoes) and napier grass. They pay IDR 2 million to rent the land per year.

The total income from dairy bussiness was IDR 3 million in last January. The income from crop farming is higher. In the last harvest time, the income was IDR 25 million during six months. If needed, a worker outside family is hired to help them in this activity. They pay IDR 50000 per worker a day.

The waste from this farm are processed in biodigester to be biogas. Unfortunately, the biodigester currently does not work. They are not yet repair it. So, the waste are evacuated to the river and to the crop land as organic fertilizer.

The evolution

Building and the equipment.

There is a change in the building included biogas installation. The waste could be processed as a biogas. However, the biodigester does not work and need to be repaired.

Feeding management.

He changed the quantity of concentrate provided to the cows. Nowadays, the quantity of concentrate is lower than in the past. He mentioned that the quality of the concentrate in the past was better than now. The cow could produce more milk with this concentrate. Currently, this farmer does not give tofu waste and brewers grains to feed the cows. The reason is that those two feed ingredients were not always available in the market. It is difficult to find it. He

also explained that if he did not provide tofu waste to the cows, the milk production decreased drastically.

The quantity of the forage was higher than now. The reason is that the number of farmers and the population of cows in the past were not too many than now, so the competition to obtain the forage was not too high.

Activity of the production

Since the beginning, they had two activities generating income. However, there were two changes; firstly, crop farming with horse tourism (1994-2001); secondly, crop farming with wage worker (2001-2003); and thirdly, crop farming with dairy farming. He has the reasons to diversify the activity. He mentioned, the income from horse tourism was uncertainty in particular in the rainy season. To be a wage worker, he spent so much time and energy. In the dairy farming, the income is relatively good and regularly paid every fifteen days. However, if he only depend on the dairy farming, it is not enough to cover all daily expenses. In addition, he can use his available time to work on other farming activity. He can obtain an additional income from crop farming (chili and tomatoes). According to him, those two activities (crop farming and dairy farming) are the best option until now.

Labor

There is a change regarding the labor. If needed such as when land treatment, harvestment, and other, he hires a man outside family labour to help him in crop farming activity. It is because the time availability. The couple cannot handle all the activity in particular when the activity needs more time and energy.

Land use

There is a change regarding the land rented. Currently, the total land rented is smaller than in the past. However, only small of them used to cultivate grass.

Herd size

Initially, the farmer only had one heifer. Then, he gradually had more number of cow. He mentioned that if he did not sell the cow or calves, the number of cows would be more than twelve. Due to his capacity (time, energy, building, and feed), he only able to take care four cows.

The limitation

To have more cows, the difficulties are capacity in barn, land to cultivate grass, and worker.

SECOND INTERVIEW

1. *Diversification versus Dairy specialization*

Mr Arun and his family have two activities generating income including dairy business and crop farming (tomatoes, chili and cabbage). They started crop farming activities since a long time, even before started dairy farming activities. The reason is that the income from both activities are important to cover daily needs. In addition, there are synergy between crop farming and dairy farming.

He explained that agriculture by-product can be used to feed the cows. Part of waste from dairy farm is also useful to be organic fertilizer. This fertilizer can reduce cost of fertilizer. Usually, he needs to buy organic fertilizer from poultry farm (IDR 1-2 million a year) but since he uses this fertilizer, it can be reduced. Unfortunately, using organic

fertilizer from his farm is a bit difficult because this fertilizer is too heavy and the distance between dairy farm and crop farm is relatively far. He must pay to transport it. Therefore, it is sometimes not efficient. The solution is that he mix between those fertilizers to get more efficient income.

He mentioned that until now, he can manage time to do both activities. In the morning, after to cut and to carry grass, he goes to the crop field. In one condition, for dairy business it will be optimal if he only has four cows. If it is more, both activities will be unwell managed due to limitation of time and worker.

2. Land access

This farmer rent land from village authority. The price is IDR 2 million per year for 250 tumbak (1 tumbak = 14 m²). Those land are used to cultivate vegetable and small size for napier grass. Farmers in this area can access land of village (owned by local authority). The important thing is money to rent it. If they have no money, land rented will be allocated to other people. This farmer explained that he saves money from milk selling or calves selling to rent land from local authority.

3. Forage access

The availability of forage in this area is limited. He explained that previously, natural grass can be found in surrounding area but now since quantity of farmers increased, farmers have to find this grass from other area. The high competition occurred between farmers to obtain forage. Mr Arun does not need outside family worker to help him on cutting and carrying grass but his wife.

In this area, he mentioned that only very few of farmers who sells grass. It is because every farmers needs those forage to feed their cows. However, it can be found in other sub-district (Cibodas) who sells grass. The price is IDR 150 thousands per pick up (one car).

In case of low quantity of forage, he prefers to have same quantity of concentrate and cassava waste and he find forage from other location. It is better because the price of concentrate is expensive and also he will have low income if do that.

4. Waste management

Mr Arun actually has biogas in barn but unfortunately this biodigester does not work. He explained that when installed biogas, there was a banana trees under this installation. So when this tree grown, it will destroy the biogas. It has to be renovated but it costs a lot. He mentioned that he received this practice from KPSBU. Every farmers can easily access this biogas with only pay IDR 100 thousands per month.

Currently, part of waste are directly evacuated to the waterways, part of them goes to crop field and others are given to other crop farmers for free. No body protests because majority of them are dairy farmers.

5. The willingness to maintain dairy farming activity, for the new generation

Eventhough, he has two activities generating income, dairy business is a still a good business. He mentioned that the income from this activity is interesting. the other reason

is that he feels free to do this activity. He can manage all by him self. In addition, he also difficult to find another job so those activities are good choices.

In the future, he expected that his children can continue dairy busines but they have to be better than parents do. Income from milk selling and the assets of cows are still interesting to continue this activity.

Monogram

	1994	2001	2002	2003	....	2015	2016	2017
1. Activities								
Crop farming	All year Vegetable (chili and tomatoes)							
Horse tourisme	Husband		Stop activity					
Wage worker			husband		Stop activity			
Dairy farming			Started dairy farming with 1 heifer					
2. Workers								
Husband	All year in crop farming and horse tourisme		All year in crop farming and part time as wage worker					
Couple			All time in crop farming and dairy farming					
Outside family labor	If needed to help on crop activities							
3. land ownership	Small size for house and barn							
Land rented	4200 m2			3500 m2				
4. cultivation								
400 m2			Napier grass					
4200 m2	Vegetable (chili and tomatoes)							
3100 m2			Vegetable (chili and tomatoes)					
5. dairy cattle								
Calves			0		Male calves will be sold and female calves will be replacement stock			
Heifer			1					0
Cows			0					3

Abstract

Title : Transformation of dairy production systems in Indonesia : assessing sustainability and long term trajectories of farms

In Indonesia, rapid economic growth and awareness to consume nutritious food boost animal source foods, consumption, including dairy. As consequence, GDP from livestock sub-sector shows an enhancement to more than 56 percent during five years (2011-2015). Even though, it remains relatively low compared to other South East Asian countries, the demand of dairy products could not be covered by national production. The national production accounted for only around 835.000 tons in 2015 which is produced mostly by smallholder farms.

Smallholder farms represent the vast majority of dairy cattle farms in Indonesia. With only 4 cows and less than 1 ha of cultivated land per household on average, dairy activities play an important role in securing the livelihoods of those smallholder farms. However, those farms face several constraints that preclude their sustainability. In that context, we wanted to research “in what condition smallholder dairy farms are more sustainable”.

Our approach aimed at evaluating the sustainability of smallholder farms and assessing the dynamics and changes in milk production systems, in West Java Province. The first phase of our study (2014) was to identify the role of a local dairy development project and the needs of the dairy farms. We collected data from 61 farms through formal survey and from milk cooperative. The second phase (2015-2016) was to evaluate the sustainability of smallholder dairy farms. After an extensive literature review, we carried out in-depth interviews with experts and local stakeholders (researchers, lecturers, government, cooperative, NGO, farmers) in order to propose six main indicators of sustainability scoring from 0 to 100. We then conducted a formal survey of 355 farmers that allowed us to quantify those indicators. The third phase (2016-2017) was to understand the dynamics of dairy farming systems. Based on the results of the formal survey of 355 farmers, we built a farm typology and characterized each type of farm. We then selected 20 farms which represented each type of farm for in-depth interviews to understand their farm trajectories.

From our study, we want to underline 3 main results. First, we show the importance of providing trainings and technical support for the development of farmers' livelihoods. Second, we note that the level of capital and the diversification of the activities on farm both play important roles in the sustainability of the farms. Third, if mixed crop-livestock systems remain stable in terms of milk production, specialized farms with higher capital endowment increased their herd size rapidly.

To conclude, farmers with diversified activity show better sustainability performances than specialized ones, but their contribution to national production increases more slowly. Specialized farm might play a key role to support national production due to rapid increase of the dairy herd. Nevertheless, in a dairy development policy to supply national market, to focus only on those specialized farms could not be relevant. Due to the high number, small-scale farms are important to reducing poverty, to opening job opportunity, to ensuring nutrition and to providing national market. In the future, dairy policies should give more emphasis to smallholders' trainings and credit programs and to provide relevant strategies considering the farm type, the sustainability pattern, the farm trajectories in order to have sustainable development.

Keywords: sustainability, smallholder farmers, milk production, farm trajectories, Indonesia

Résumé

Titre : Transformation des systèmes bovins laitiers en Indonésie : évaluation de la durabilité et des trajectoires des exploitations

En Indonésie, la croissance économique rapide et la sensibilisation à la consommation d'aliments nutritifs sont des facteurs importants qui stimulent la consommation d'aliments d'origine animale, y compris laitiers. Le PIB de l'élevage a ainsi augmenté de plus de 56% entre 2011 et 2015. Même si elle reste relativement faible par rapport aux autres pays d'Asie du Sud-Est, la demande de produits laitiers n'est pas couverte par la production nationale. Celle-ci ne représentait qu'environ 835 000 tonnes en 2015, produites principalement par des petites exploitations familiales.

Les petites exploitations familiales représentent la grande majorité des fermes laitières en Indonésie. Avec seulement 4 vaches et moins de 1 ha de terres cultivées par ménage en moyenne, les activités laitières jouent un rôle important dans la sécurisation des moyens de subsistance de ces petites exploitations. Cependant, ces fermes font face à plusieurs contraintes qui empêchent leur durabilité. Dans ce contexte, nous souhaitons rechercher «dans quelle mesure les petites exploitations laitières peuvent-elles être plus durables ?».

Notre approche visait à évaluer la durabilité des petites exploitations et à apprécier la dynamique et les changements dans les systèmes de production laitière dans la province de Java Ouest. La première phase (2014) consistait à identifier le rôle d'un projet de développement laitier local et les besoins des fermes laitières. Nous avons recueilli des données auprès de 61 fermes à travers une enquête formelle et auprès de la coopérative laitière. La deuxième phase (2015-2016) consistait à évaluer la durabilité des petites exploitations familiales. Après une revue de bibliographie, nous avons mené des entretiens avec des experts et des acteurs locaux (chercheurs, experts, gouvernement, coopérative, ONG, agriculteurs) afin de proposer six indicateurs de durabilité. Nous avons ensuite mené une enquête formelle auprès de 355 agriculteurs, ce qui nous a permis de quantifier ces indicateurs. La troisième phase (2016-2017) consistait à comprendre la dynamique des systèmes de production laitière. Sur la base des résultats de l'enquête formelle de 355 agriculteurs, nous avons construit une typologie agricole et caractérisé chaque type de fermes. Nous avons ensuite sélectionné 20 fermes qui représentaient chaque type de ferme pour des entretiens approfondis afin de comprendre leurs trajectoires.

Nous voulons souligner 3 résultats principaux. Nous montrons l'importance de fournir des formations et un soutien technique pour le développement des moyens de subsistance des agriculteurs. Nous notons que le niveau de capital et la diversification des activités à la ferme jouent un rôle important dans la durabilité des exploitations agricoles. Enfin, si les systèmes mixtes agriculture-élevage restent stables en termes de production laitière, les exploitations spécialisées disposant d'une dotation en capital plus importante ont rapidement augmenté leur taille de troupeau.

En conclusion, les agriculteurs ayant une activité diversifiée affichent de meilleures performances en matière de durabilité, mais leur contribution à la production nationale augmente plus lentement. Les fermes spécialisées pourraient jouer un rôle clé pour soutenir la production nationale en raison de l'augmentation rapide du cheptel laitier. Néanmoins, dans une politique de développement laitier il ne serait pas pertinent de se concentrer uniquement sur ces exploitations spécialisées. En raison de leur nombre élevé, les petites exploitations jouent un rôle important dans la réduction de la pauvreté, la création d'emploi, l'alimentation et la fourniture d'un marché national. À l'avenir, les politiques laitières devraient mettre davantage l'accent sur les formations et les programmes de crédit des petits exploitants et fournir des stratégies pertinentes tenant compte du type de ferme, du modèle de durabilité, des trajectoires agricoles afin d'assurer un développement durable.

Mots Clés: Durabilité, trajectoires d'exploitations, petits producteurs, production de lait, Indonésie