Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.8, No.6, 2017

Sustainability Status of Biology Dimension of Local Beef Cattle Development in the Dryland Region, Indonesia

Maximilian M.J. Kapa[1]* Soemarno[2] Bagyoyanuwiyadi[3] Suyadi[4]*
1.Graduate School of Environmental Science, Brawijaya University Malang Department of Agribusiness Faculty of Agriculture,Nusa Cendana University, East Nusa Tenggara, Indonesia
2.Department of Soil Science, Faculty of Agriculture, Brawijaya University, Malang, East Java, Indonesia
3.Department of Biology, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang, East Java, Indonesia
4.Department of Animal Science, Faculty of Animal Husbandry, Brawijaya University, Malang, East Java, Indonesia

Abstract
The study examined the sustainability of local beef cattle production the dryland area of Kupang Regency. The aims of the study were (1) to determine the sustainability status of Biology Dimension, (2) to determine sensitive attributes influencing the index value and status of biological Dimension Sustainability and, (3) to formulate policy priority that can be implemented to development of local beef cattle in the dryland environment of Kupang Regency Indonesia. To obtain data, several steps were done i.e. interviewed respondents using questionnaires, focus group discussion and observations. The Rap-UTSP-Laker was used to examine the sustainability status of the local beef cattle development system both in lowland and upland farming systems. Results of the study revealed that the Biological Dimension is in less sustainability category with the sustainability index of 40.77 % for upland and 40.40% for lowland systems. The result also indicated that among 10 attributes, 5 attributes were considered to be very sensitive and the most critical attribute was number of trade out cattle.
Keywords: beef cattle, biology dimension, farming systems, lowland, upland, dryland, sustainability

1. Introduction

Livestock development especially beef cattle is directed to increase its productivity by which the income and welfare of farmers are achieved. Beef cattle are raised by almost farm households in East Nusa Tenggara (ENT) Province, Indonesia. The role of beef cattle is very important in economic development of the region. It can be seen from its contribution to the province Gross Regional Domestic Product (GRDP) which tends to increase from year to year. In 2010 for example the contribution of livestock sector to GRDP ENT based on constant price was Rp 3,900 billion, while in 2014 it increased to Rp 4,895 billion (BPS NTT, 2015. These values derived from exported value of 60.000 heads per year [Suhadi, 2016]. That is why, the government of ENT and especially Kupang Regency has released a special policy to boost beef cattle production through putting beef cattle as a priority commodity in economic development of the region.

Dispate the economic benefits of beef cattle, there are some serious problems dealing with beef cattle development such as technical, social, and policies that hinder the development of local beef cattle, which until now have not been resolved yet. Behind the significant economic benefits, conditions of beef cattle farms in this area are very alarming. Jelantik et al. (2007) noted that most of the cattle both exported cattle and for local consumption are not produced by productive and efficient systems; rather they come from the traditional farming systems with low productivity.

It is well known that beef cattle system in ENT is kept under extensive traditional regime. Knowing the characteristics of extensive management system of local cattle (Bali cattle) in ENT is helpful to identify the problem and the formulation of strategies for improving cattle productivity. Extensive traditional management system is defined as a way of husbandry where the cattle released during the day and stabled at night, and or released on grazing day and night. In this condition, the owner intervention is very limited.

Population growth will normally followed by increasing demand for meat as a source of animal protein. The increase of demand on the one hand would boost economic growth but on the other hand will cause a negative impact on the sustainability of the local beef cattle reared under the extensive system. With the current husbandry system, the threats to the business sustainability of beef cattle farms in the dryland environment may occur. Therefore, a study to know the status of the sustainability of local cattle reared extensively in the Dryland area of Kupang Regency, ENT Province of Indonesia from biological dimension perspective is important to be done.

2. Research Method

2.1 Research Location

This study was conducted from June to September 2016 at Pukdale Village, East Kupang Sub District, and

Pakubaun village, East Amarasi Sub District, Kupang Regency, ENT Province Indonesia. Pukdale village represents the rice fields (lowlands) farming systems, whereas Pakubaun village represents upland farming systems.

Pukdale is located in the lowland area at an altitude of 0-50 m above sea level (asl). While Pakubaun is located at an altitude of 40-327 m asl. Both areas are influenced by two season namely dry season and rainy season. Dry season is longer (8-9 months) while rainy season only last for 3-4 months)

2.2 Type and source of data

This research used primary and secondary data. Primary data were collected from 56 respondents' farmers and 15 respondents of stakeholders (experts), representing farmer groups, Academic staff, government officers, researchers, and NGO, survey and field observation. Primary data consisted of attributes that related to Biology Dimension and these data can be generated from farmer respondents, stakeholders as well as from direct field observation. While secondary data were obtained from several sources such as research reports, annual reports and documents from Research Institutes, Statistic Bureau, and from Government Bodies that relevant to this research.

2.3 Analysis method

The data collected were analyzed using ordination technique of Rap-*UTSP*-Laker *(Rapid Appraisal for Multidimensional scaling)*. This method is modified from *RapFish,* the method that was used to evaluate fisheries sustainability through Multidimensional (Pitcher et al. 1998; Pitcher, 1999; Pitcher, and Preikshot. 2001). *Leverage analysis* was used to determine the significant level of each attribute influences the sustainability of beef cattle system. Furthermore, *Monte Carlo analysis* was employed to evaluate the effect of error of attribute(s). If the difference between Monte Carlo sustainable index and MDS sustainable index is < 1 meaning that the effect of error in the analysis is small (Kavanagh, 2001)

2.4 Analysis process of Rap-UTSP-Laker

Several stages have to be done before hand in order to run RAP-USTAP-LAKER analysis. Those are (Fauzi and Anna, 2005):

1. Determining Attributes for Biology Dimension,
2. Valuating all Attributes in ordinal scale based on sustainability criteria for Biology Dimension,
3. Data *Analysis* using *RAPFISH software,*
4. Examining *the* sustainability status and index values of Biology Dimension,
5. Examining *sensitive* attribute(s) influencing sustainability using Sensitivity analysis *(leverage analysis),*
6. Examining error effect in calculation process using *Monte Carlo analysis*

3. Result and discussion

3.1 General information of the study area

Kupang Regency, where the study was carried out, is located in West Timor Indonesia and is one of beef cattle centre in Indonesia. It has 24 sub districts with area of 5,298.13 Km^2 and length of coastline is 442.52 km^2. The regency has population of 328 688 comprised 168 316 males and 160 372 females. Geographically Kupang Regency is located between $9^o15'11.78"$ South Latitude and $123^o16'10.66"$ to $124^o13'42.15"$ East Longitudes (BPS Kabupaten Kupang, 2016) see Fig. 1

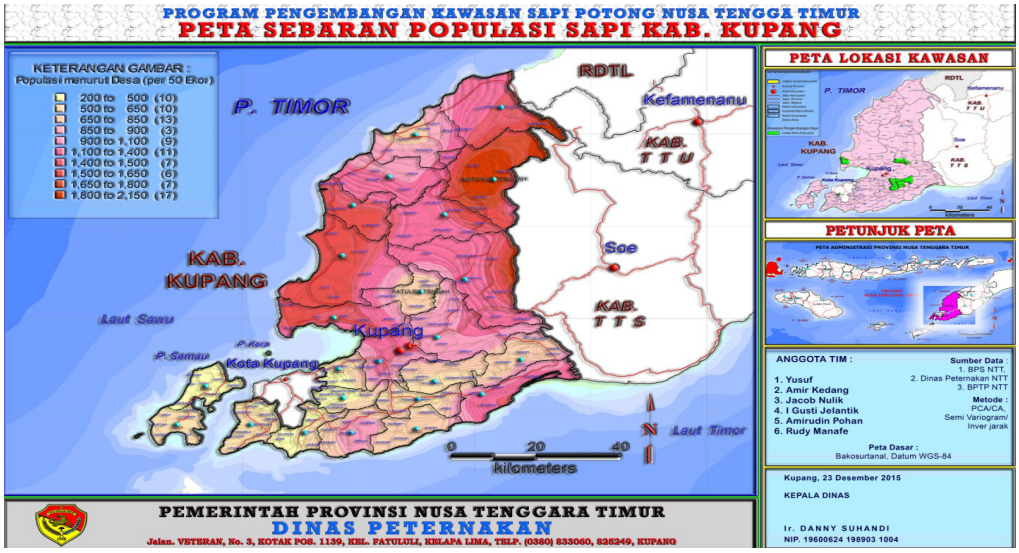


Figure 1. Map of Kupang Regency, East Nusa Tenggara Province Indonesia

Land surface in Kupang Regency can be described as hilly, mountainous, and few parts are flat. However, most of the area is located on 0-500 meters above sea level. Kupang Regency has two seasons, namely Dry Season and Rainy Season. Dry season normally starts from June to September, while Rainy Season starts from December to March. The total rainfall in 2014 was 960 mm and annual average temperature was 27.5 ^{o}C ranging from 21^{o}C to 36.5 ^{o}C (BPS Kabupaten Kupang, 2016).

The dominant flora in the area are, (a) estate crops such as coconut, cashew, *Ceiba Petandra*, candlenut, Coffee, and areca nut, (b) the main food crops commodities are, maize, cassava, yams and nuts, (3) the dominant forestry commodities are Mahogany, Tamarind, Coconuts, bamboo and mangrove.

Table 1. Population of Selected Livestock in Kupang Regency, 2011-2015

Livestock Type	Year				
	2011	2012	2013	2014	2015
Beef Cattle	159,124	151,254	159,124	149,243	186,553
Goats	46,510	34,053	34,735	36.492	42,328
Pig	79,632	69,766	71,161	74,763	112,143
Poultry	312,209	284,964	135,576	106,166	166,677

Source: BPS Kabupaten Kupang (2013); Pemda Kabupaten Kupang (2013)

Fauna in Kupang Regency comprises large livestock, small livestock and poultry. Large livestock namely, cattle, buffalo and horses, while small livestock consists of goats, pigs, sheep, dogs and deer. Data presented in above table explain that poultry is the dominant livestock in the region, this includes chicken and duck (wild duck). Among large animal, beef cattle is the important livestock for farm households. As seen in Table 1, the population of all animals fluctuated within the period of 2011-2015. Compared with other livestock, poultry population is very significant decline due to disease and poor management of husbandry.

3.2 Sustainability Analysis of Local Beef Cattle Development in Kupang Regency

The Biological Dimension sustainability Analysis of local beef cattle development in the dryland environment of Kupang Regency was done through evaluating ten attributes (Table 2). These attributes obtained through discussion with relevant experts in the field under study.

Table 2. Biological dimension and attributes of sustainability

No	Attributes
1	The nature of the cattle farm
2	Population dynamics Trends of cattle
3	The number and composition of herds per group (Herd Size)
4	Slaughtering rate of productive cattle
5	Natural Increasing of cattle population
6	Number of cattle entering the group
7	Number of trade out cattle
8	Calving rate
9	Mortality rate
10	Sex Ratio

Results of the analysis using RAP-UTSP-Laker showed that the value of biology sustainability index of local beef cattle development both in upland and lowland system in the dryland environment, Kupang Regency was 40.77 % and 40.40 % respectively (on sustainable scale of 0-100 %). Both values indicated that the sustainability status of the Beef Cattle Development in dryland environment, Kupang Regency, Indonesia was categorized as less sustainable from Biological Dimension perspective. Valuation concerning sustainability status and critical factors based on RAP-UTSP-Laker method can be seen in Figure 2.

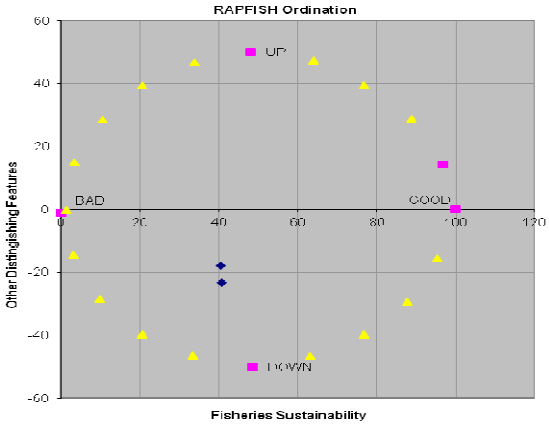


Figure 2. Sustainability Ordination of Rap-UTSP-Laker.

3.3 Leverage analysis (Sensitive analysis)

Leverage factor is a strategic factor in management activities in the future. Leveraging analysis aims to look at the change in the error value of determination of the sustainability value if one of the attributes is removed from the analysis. Stepwise method was employed to analyze the Sensitivity (leveraging) factors by calculating the root mean square (RMS) of attributes. The Root Mean Square of each attribute of Biological Dimension can be seen in Figure. 3.

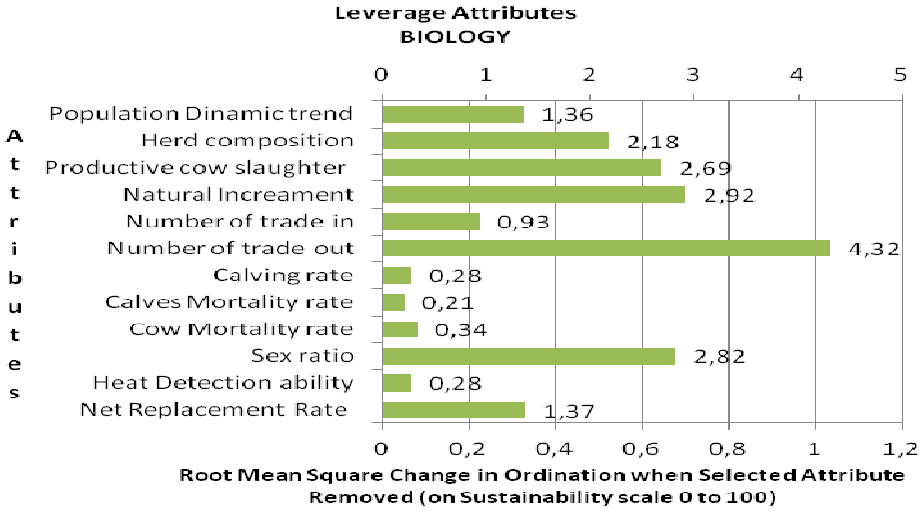


Figure 3. Sensitive attributes influencing biology dimension sustainability

Sensitivity Analysis using leveraging attributes revealed that 5 out of 10 attributes are critical attributes that significantly influenced the sustainability index value. These are, number of trade out cattle, the number and composition of herds per group (herd size), The nature of the cattle farm, Mortality Rate, and Natural Increasing of cattle population. Therefore, policy should be directed to matters relating to number of trade out cattle, the composition balance of cattle per group, improvement of the management system of beef cattle with extensive traditional system and reducing mortality rate of livestock, especially cattle cows by intensifying role of extension worker and continue to disseminate good practice of livestock farming. These five attributes are:

1. Trade out animal; from the analysis, it was found that is the most critical attribute that affect the sustainability status. It is associated with sales system of cattle that are not controlled. Owners sell their animals at any time when there is an urgent need. So that, the number of cattle in and out of each farmer household is not balanced. Although the government has issued a law concerning quota restrictions and a ban on the sale of productive cattle but these rules are not complied with by farmers.

2. The number and composition of cattle per group (herd size); in the traditional extensive rearing system, number and composition of cattle varies greatly. The results of this study showed that the majority of farmers in both study areas have a small herd size (1-2 head) and only few household farmers who have cattle more than 100 heads. This is supported by research conducted by Mullik et al. (2004) who found that about 90 % of farmers only have a small herd size. The impact of these conditions is although the birth rate could achieve > 90% this group of cows have not been able to increase average birth rate to the minimum expected calving rate of 85 %.
3. The Nature of Beef cattle farm; Beef cattle business in both study areas is dominated by small-scale farm and the cattle business is a hereditary business. Although beef cattle have a significant economic contribution in the family income, farmer respondents consider the cattle farm as a side business and it is not supported by adequate capital and proper husbandry management.
4. Mortality Rate**;** Mortality rate of beef cattle under extensive regime in the study area is quite low compare to other studies. This study discovered the mortality rate in lowland and upland farming systems was 4.9 % and 9 % respectively. Actually, previous studies found the mortality rates of cow and calf can reach 30 % at time. Several scientist (Wirdhayati, (1994); Ngobe, et al. (1995); Thalib et al. (2003); and Jelantik et al.(2009) in their current research found that the mortality rate of beef cattle in West Timor was 35 % at time. Economic losses due to the high mortality rate can reach Rp18-200 billion per year (Mulik and Jelantik, 2009)
5. Natural Increase **(**NI); NI by definition is the difference between percentage of birth rate and percentage of mortality rate (Sumadi, et al, 2001). In the case of beef cattle, NI is calving rate minus mortality rate. Result of this study in the lowland farming system showed that the Calving Rate was 20.5% and the mortality rate was 4.9%. While in the upland system the Calving Rate was Therefore, NI or lowland system and upland system was 15.60 % and 8.20 % respectively. These values according to sustainability criteria are categorized as very low. These results were lower than result of the study of Budiarto et al. (2013) with the same type of cattle (Bali Cattle) who found the NI of 27%. While Tobbesi, et al. (2009) explained that NI of Bali Cattle in Timor Tengah Utara Regency was 21.72 %. The result explained that the number of productive cows is not sufficient; this is exacerbated by poor management system of cows in the area.

Improving these 5 attributes especially trading out beef cattle will in turn increasing the sustainability status of Biological Dimension of local beef cattle development in the dryland area of Kupang Regency.

3.4 Monte Carlo (MC) Simulation Analysis

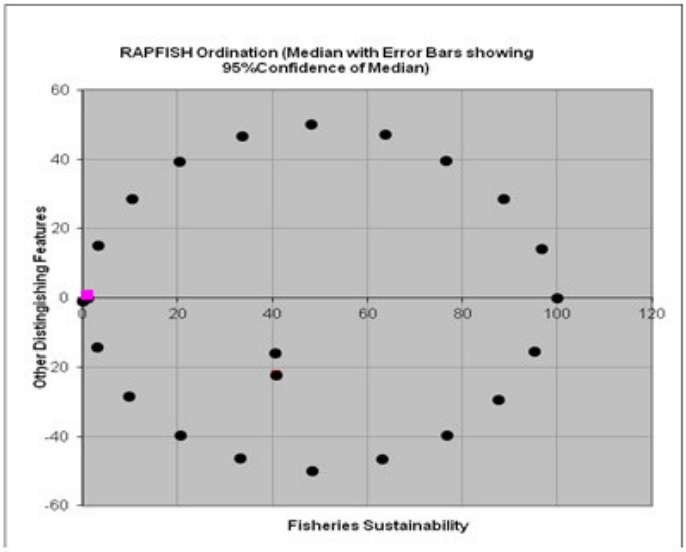
This analysis was done to test the error factor in sustainability analysis as well as to overcome uncertainty aspects. The uncertainty is caused by several factors such as scoring mistake impact as a result of lack of information, variation in scoring impact due to valuation mistake, mistake in data entry and high stress value.

Monte Carlo analysis is used to assess the magnitude of the error factor in sustainability analysis, which is derived from the difference way in assessment of the attributes by each respondent, an error in data entry, and incomplete or missing data (Fauzi and Anna, 2005). The result of the Monte Carlo simulation on sustainability index in each farming system can be seen in Table 3 and Figure 4.

Table 3. Sustainability index Values of MDS and Monte Carlo

Farming Systems	Index (%)		Difference
	MDS	MC	
Upland	40.77	40.72	0.05
Lowland (Rice Field)	40.40	40.30	0.10

Validity test was done with a Monte Carlo analysis by comparing the value of sustainability index with the Monte Carlo index value. Data in Table 3 and Figure 4 present the result of Monte Carlo analysis at the confidence level of 95%. The value of Monte Carlo Index for Lowland and Upland farming systems is 40.72 % and 40.30 % respectively. The difference between MDS Index and Monte Carlo is very small i.e. 0.05 and 0.10. Both values are less than 1 it means that the MDS analysis model generated is adequate to estimate the sustainability index of local beef cattle business Development in Kupang Regency



(2)

(3)

(5)

Figure 4. Result of Monte Carlo simulation analysis

3.5 Accuracy Test of MDS Analysis (Goodness of Fit).

The results of the analysis found the determinant coefficient (R^2) was 95.43 % or close to 100 %, it means that the prediction model of sustainability index was good and adequate (Kavanagh, 2001). The study revealed that stress value is 0.13 or less than 0.25. Based on the *stress value*, it can be said that MDS analysis model has a high accuracy (goodness of fit) and be suitable for assessing the sustainability index (Fauzi and Anna, 2005). This is in accordance with the opinion of Kavanagh (2001) that if the stress value is smaller than 0.25 and the coefficient of determination (R^2) close to 1.0 then this indicates that the level of accuracy of the analysis results can be accepted.

4. Conclusion

Sustainability status of biology dimension *of* local beef cattle development in two different farming systems in the dryland environment of Kupang Regency, ENT Province Indonesia was less sustainable with the index value*s* of 40.77 % for lowland and 40.40 % for upland farming systems. There are 5 sensitive attributes that influence local beef cattle development in two different farming systems in the dryland environment of Kupang Regency, ENT Province Indonesia. However, the most sensitive (critical) attribute was number of trade out cattle. Priority policy to improve the Biology Dimension sustainability should be given to control trading system of beef cattle in the two areas followed by improving rearing management of Local Beef Cattle in dry land area of Kupang Regency.

Acknowledgement

The authors would like to thank *Ministry of Research Technology and Higher Education through Research Institute Nusa Cendana University.*

References

BPS Kabupaten Kupang. (2015), Kabupaten Kupang dalam angka Tahun 2015. Badan Pusat Statistik Kabupaten Kupang.

BPS Kabupaten Kupang. (2016), Kabupaten Kupang dalam angka 2016. Badan Pusat Statistik Kabupaten Kupang.

BPS NTT. (2015), "Nusa TenggaraTimur dalam angka 2015". Badan Pusat Statistik Nusa Tenggara Timur, Kupang.

Budiarto, A., Hakim, L. Suyadi, Nurgiartiningsih,V. M. A., & Ciptadi, G. (2013), "Natural Increase Sapi Bali di Wilayah Instalasi Populasi Dasar Porpinsi Bali". *J. Ternak Tropika* **14** (2), 46-52. [on-line] Available: http://ternaktropika.ub.ac.id/index.php/tropika/article/viewFile/182/181 (Accessed on 5th January 2017).

Fauzi, A. and Anna, S. (2005), "Pemodelan Sumberdaya Perikanan dan Kelautan (Untuk Analisis Kebijakan". Penerbit PT Gramedia Pustaka Utama. Jakarta.

Jelantik, I. G. N, Manggol, Y. H., Jegho, Y., Sutedjo, H., Keban, A., Kune, P., Deno Ratu, R., Sogen, J., Kleden,

P., Jermias, J, & Leo Penu, C. (2007), "Kajian Mutu Genetik Sapi Bali di Nusa Tenggara Timur". Laporan Akhir. Fapet Undana.

Jelantik , I. G. N., Mullik, M. L., & Copland, R. R. (2008), "Mortality Rate of Bali Cattle Calves in West Timor, Indonesia". *Proceeding* 27th ASAP Conf. p48.

Kavanagh, P. (2001), "Rapid Apriasal for Fisheries (Rapfish) Project. Rapfish Software Description (for Microsoft Excel)". University of British Columbia. Fisheries Centre, Vancouver. Canada.

Mullik, M. Lay, W. A., Sanam, M. U. E., Kune, P., Tiro, M., Joko, E., Nesimnasi, N., & Nada Kihe, J. (2004), "Pengembangan Village Breeding Centres Saapi Bali di Kabupaten Timor Tengah Utara. Laporan akhir Kerjasama Dinas Peternakan Kabupaten TTU dan Fakultas Peternakan Undana Tahun 2000-2004".

Mulik, M. Jelantik, I. G. N. (2009), "Strategi Peningkatan Produktivitas Sapi Bali pada Sistem Pemeliharaan Ekstensif di Daerah Lahan Kering: Pengalaman Nusa Tenggara Timur. Makalah Seminar Nasional Pengembangan Sapi Bali Berkelanjutan dalam Sistem Peternakan Rakyat". Mataram, 28 Oktober 2009

Nggobe, M., Bamualim, A., & Wirdahayati, R. B. (1995), "Pengaruh Pengaturan Pola Perkawinan Terhadap dan Aplikasi Hasil Penelitian Peternakan Lahan Kering". Balai Penelitian Ternak Lili, Kupang.

Pemda Kabupaten Kupang. (2013), "Profil daerah Kabupaten Kupang". Pemerintah Daerah Kabupaten Kupang.

Pitcher, T.J., A. Bundy, D.B. Preikshot, T. Hutton & D. Pauly. (1998), "Measuring the unmeasurable: a multivariate interdisciplinary method for Rapid Appraisal of Health of Fisheries", Pages 31-54 in Pitcher, T.J. Hart, P. J. B. and Pauly, D. (Eds) Reinventing Fisheries Management, Kluwer Academic, Dordrecht.

Pitcher, T. J. (1999), "Rapfish, A Rapid Appraisal Technique for Fisheries, and Its Application to the Code of Conduct for Responsible Fisheries", FAO Fisheries Circular. No. 947. Rome, FAO. 1999.

Pitcher, T. J. & Preikshot, D. (2001), "RAPFISH: Rapid Appraisal Technique to Evaluate the Sustainability Status of Fisheries", *Fisheries Research* **49**(3): 255-270. Fisheries Center University of British Columbia. Vancouver.

Suhadi, D. (2016), "Selanyang Pandang Pembangunan Peternakan Nusa Tenggara Timur [on-line] Available: http://www.disnakprovntt.web.id/ (Accessed on 6th February 2016)

Sumadi, W. Hardjosubroto, N. Ngadiyono, & S. Prihadi. (2001), "Potensi Sapi Potong di Kabupaten Sleman Analisis dari Segi Pemuliaan dan Produksi Daging". Fakultas Peternakan Universitas Gadjah Mada, Yogyakarta.

Thalib R.B., Eintwistle, K., Siregar, A., Budiarti-Turner, S., and Lindsay, D. 2003. Survey Population and production Dynamics of Bali Cattle and Exsisting Breeding Programs in Indonesia. In. Eintwistle, K. &. Lindsay, D: Strategies to Improve Bali Cattle in Eastern Indonesia. *ACIAR Proceedings No.110,* 2-9.

Tonbesi, T. T., Ngadiyono, N., & Sumadi. (2009), Estimasi Potensi Dan Kinerja Sapi Bali Di Kabupaten Timor Tengah Utara, Propinsi Nusa Tenggara Timur. *Buletin Peternakan*. **33**(1): 30-39, [on-line] Available: http://download.portalgaruda.org/ article.php?article=68433&val=299 (Accessed on 26th November 2016)

Wirdahayati, R.B. (1994), "Reproductive Characteristicsof Bali and Ongole Cattle in East Nusa Tenggara Timur, Indonesia". *PhD Dissertation*. Department of Farm Animal Medicine and Production. The University of Queensland. Australia.