The Prospects of Brown Cane Sugar–Cattle Production Integration for Rural Economic Development in South Sulawesi, Indonesia

by Rahim Darma[1], A. Majdah A. Zain[2], and A. Nixia Tenriawaru[1]

[1]Department of Agricultural Socio-economics, University of Hasanuddin, Makassar, 90245 Indonesia

[2]Department of Agribusiness, University of Islam Makassar, Makassar, 90245 Indonesia

Authors' contributions

The study was carried out in collaboration between all authors. Authors RD and AMAZ designed the study; produced data gathering instrument, coordinated data collection. Authors RD and ANT conducted data gathering and analysis, while authors RD and AMAZ wrote the draft. All authors read and approved the final manuscript.

Abstract

Sugar is a strategic commodity that has become one of the leading import commodities in recent years. Integration of brown cane sugar (BCS) with cattle production is a great business opportunity that can be developed for rural economic development. This integration can optimize the use of marginal lands, and facilitate the development of environment friendly organic farming. The research objective was to identify the potential for the development of BCS-cattle production integration based on land resources, technology, culture, labor force, and markets. Data were collected through focus group discussions and interviews of 75 randomly selected farms from three districts (Barru, Wajo, and Bone). The results showed that there is a huge potential of 302,771 ha's cultivated farm land, comprising of 10,355 ha's rice fields, 86,753 ha's dry land, and 205.663 ha's paddock grazing. Cattle raising is a cultural activity and major source of income for most rural households. BCS-cattle production integration can generate employment opportunities, promote sugar and meat import substitution, produce biogas as an alternative energy source, organic fertilizer, and promote organic-based farming system. For this system to be successful, government support is needed in establishing pilot projects at various locations which are expected to encourage farmers to adapt and develop the integrated farming system for rural economic development.

Key words : Integrated farm, appropriate technology, organic farm, rural employment.

Rationale

An irony has occurred in Indonesia as a tropical agricultural country where most of the agricultural products can be generated, but has imported almost all foods. Meanwhile, a lot of agricultural land is not utilized in the form of concession or controlled individually with many landless farmers. These conditions make less attractive of countryside sector and encourage high urbanization. The unemployment rate in Indonesia has increased drastically from 3.2 percent in 2000 to 8.9 percent in 2009 where the unemployment rate in urban areas is higher than in the

country side. In 2009, the urban unemployment rate was 11.4 percent higher than in the country side which *about* 7.6 percent in the rural sector. The same thing happened to women unemployment than that of men; amounting to 10.7 and 7.8 percent respectively (BPS, 2011). Potential areas for sugar cane development in South Sulawesi are approximately 91,108 ha's which consist of 10,355 ha's paddy fields and 86,753 ha's dry land. Pasture land is also a partly potency converted into cane fields for the small scale cane sugar industry development and at the same time integrated with cattle development.

Sugar is a strategic commodity in Indonesia's economy as it belongs to the group of a nine-basic needs for daily consumption. In 2010, total national sugar consumption both industrial and household consumption amounted to 4.55 million tons, while domestic production is only 2.44 million tons of sugar, so the rest are met by imports (DGI, 2013). For production to keep pace with consumption of sugar it is due to several reasons, namely the decline in sugar cane plantations because the land is converted to residential and industrial areas, the decline in yield, continuously declining price of sugar, and decrease in plant efficiency (Aries and Tinaprilla, 2012).

Characteristics of the cane sugar industry is developed in household scale, which is suitable to be developed for rural population; including the poor and women, and much more work items suited for labor in rural areas, including women. The development of brown cane sugar (BCS) can be integrated with cattle so that the results of the production of beef from the shoots and leaves of the sugar cane are used as feed materials for cattle. Cattle feces and urine waste can be processed to produce organic fertilizer and biogas. Manure as fertilizer is a substitution of part chemical fertilizers and supporting organic farming development and biogas as an alternative energy source. The research objective was to identify potential land resources, technology, culture, and the market for the development and BCS-cattle production.

Increased production of sugar cane serves as import substitution, export commodity, which drives regional economic development, supports an increase in the cattle population, provides feeds for cattle to increase animal protein, meet import substitution, promote organic fertilizer to substitute chemical fertilizer, and encourage organic agriculture. Development of integrated sugar cane with cattle is an appropriate concept for rural economic development because it will generate huge employment opportunities for the rural population, especially for poor households through agricultural land less productive using.

Conceptual Framework

Integrated BCS-cattle Development

Markets, natural resources, appropriate technology, and culture are a great potential for the development of BCS and beef cattle production integration. Sugarcane can be developed easily on marginal or not utilized lands. In intuitively, many sugarcane is planted on asphalt sidewalk in both rural and urban areas, and can grow without well maintained. Cultivation of sugar cane has long been known by the Indonesian farmers in, including processed into brown

sugar or palm sugar substitute such as specific used as *Saka*, raw vinegar, and sweetener in Japan (Astuti, 2009).

Cane processed into BCS could be regarded as a culture of farmers in some rural communities in Indonesia. Brown sugar is widely used for household consumption as a sweetener, flavor and color enhancer. Brown sugar can change the soft food texture than crystal sugar and used as a raw material for small food and beverage industries such as soy and *Tauco* industries using brown sugar as a sweetener (Akzar, 2012). In addition, brown sugar is one alternative that can meet the needs of sugar in Indonesia (Sinaga, 2009).

Growing cane and cattle simultaneously to produce BCS and beef is an integration of farming and organic agriculture as well. Integrated BCS-Cattle farm is an innovation to the farmers as well as increase their knowledge and skill for organic farm and sustainable agriculture. The importance of organic farming for the perspective of sustainable agriculture development could be found in several studies (Eghball, et al., 2004; Kaur, et al., 2005; Kihanda, et al., 2006; and Yaduvanshi, 2003). A set of agricultural technologies or innovation which were simple, effective and need based were selected and implemented to improve the knowledge, skills and abilities of farmers (Kalyani, et al., 2013). Cultivated crops and livestock is an integrated system for efficiency resource used, maintaining productivity , protecting the environment and the health of farmers and their families and at the same time adopting sustainable agricultural system (Hesterman and Thorburn, 1994). Integration of farming will also provide higher revenues due to reducing the use of external inputs. Integrated farming is a pattern of land use on a regular basis, takes place naturally, and not using the external input (El Titi, 1992). The integration of farming also encourages farmers to develop organic farming. Organic agriculture is an integrated farm that aims to reflect the strong linkage between farm biota, production and the environment as a whole (Mannion, 1995). Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony (IFOAM, 2007).

BCS-cattle production integration is a combination of two effective technologies that can be easily developed by farmers. Appropriate technology (AT) is an alternative method to overcome the problems encountered in agriculture, whether in relation to the development, production, development opportunities, or the creation of employment opportunities. AT is a technology appropriate to the needs of the community, to address the problem of society, and to preserve environment, and easily utilized by the community, to generate additional value from the economic and environmental aspects (President Act No. 3, 2001). BSC processing technology as an AT is cheap and easy and has huge potency in rural area to overcome the problem in converting natural resources, absorbing unemployment, encouraging domestic industry, and increasing incomes, especially for rural economy.

Rural Employment Development

Rural workers have low skills and are flexible in entering the employment opportunities available in rural areas, especially in agriculture and the informal sectors. Therefore, it is necessary to develop a relatively inexpensive investment in which can be easily developed locally so that rural unemployment and urbanization can be resolved. The skill level of work needed for the BCS-cattle production integration is generally lower and matching with mostly rural employer. Low human capital, education and experience are dominant characteristics for rural labors (Renes and Ridder, 1995; Gorgens, 2002; Wolf 2002).

The problem of unemployment is not only economic issues but more related to social issues. Types of jobs created in the economy must be in accordance with the capabilities and expectations of the work force (Suryadarma, et al., 2007). One of the efforts to boost growth through human resources investment is creating agricultural economic activity which has a potential market of products, available local resources, and supported by innovations for appropriate technology. In an era of global trade liberalization tends to drive demand for specific products environmentally friendly, and produced naturally will have a strong bargaining position because it can be developed as an industrial super labor intensive, involving many members of rural communities (Darma, 2012). Small scale Integrated BSC-Cattle is a new technology easily adopted by rural people or famer with low level of education and skill, large number of family labor, especially with female labor. It could be also considered as training process for local people on the low input for external sustainable development.

The BCS development is the reverse of many intensive or commercial commodity. The study conducted by Baffoe-Asare, et al. (2013) indicated that social capital and training are variable strongly and significantly influenced adopted technology on cocoa farm. The small scale industrial development based on BCS-cattle production integration is a concept of labor transformation from urban to rural area. Although this is contrary to the concept proposed by Feridhanusetyawan and Stahl (2001) that the transformation of labor in the global competition has drastically changed from rural to urban areas, from low-technology-based industry to modern technologies, or from low-tech and labor-intensive industries to capital-intensive modern industry.

Employment in agriculture and the urban informal sector can be expanded due to the labor market and the social structure of the sector which is sufficiently flexible to absorb the workers who are not absorbed in the formal sector (Wie, 2007). At the same time, the capacity of community is needed and be improved through intensive labor investment with appropriate technology as a potential way to improve rural employment and the quality of human resources (Darma and Arsyad, 2010). So the development of BSC-cattle integration is an economic development concept for rural economic development. The rural labor development is a key strategy for rural development of agricultural countries (Ellis,1998; Foster and Rosenzweig, 1995).

Research Method

The study was conducted in three districts as the center of the development of cattle in South Sulawesi, Indonesia. Barru district is the center of Bali cattle germ plasm development, Wajo district is an area that generates BCS in the 1960s, and Bone district is an area of the largest sugar cane planting area in South Sulawesi. South Sulawesi is one province in Sulawesi Island and geographically located in central part of Indonesia

Primary data was collected by the method of focus group discussions and interviews with a sample randomly selected farmers of 30 farmers in Barru district, 25 farmers in Wajo district, and 20 farmers in Bone district. The data collected include methods of animal husbandry, the potential development of intensive stall, sugar cane plantation and cultivation of BCS. Secondary data of covering area of unutilized agricultural land, grazing area, sugar cane planting area, and the BCS development site were taken from South Sulawesi Statistical Bureau. Qualitative analysis was used to describe the development prospects of integration BCS-cattle based on the potential of natural resources, appropriate technology, culture, labor force, and market.

Result and Discussion

Land Resources Potency

The development of cane and cattle in South Sulawesi has a huge potential. Sugar cane can be developed in the area of non cultivated agricultural land and grazing land, while cattle can be developed by utilizing an abundant unutilized agricultural waste. For farmers who have extensive business orientation and are supported by labor, paddock grazing land can be converted to cane farm and be integrated with cattle.

There are about 205.663 ha of uncultivated agricultural land or 8:44 per cent of the total agricultural land in South Sulawesi in 2010 which could be classified as a potency for cane development. Agricultural land area of 2,434,968 ha's in 2010 consist of 582,444 ha's of rice field and 852,524 ha's dry land (not for paddy). Approximately 10,355 ha of rice fields or 1.78 percent of the total paddy fields, while 86,753 ha's or 4.68 percent of the total area of dry land are not cultivated.

Table 1 The potency land cultivated and non-cultivated for cane development (ha)

No.	Kinds of Land	2007 (ha)	2010 (ha)	Changes (ha)	Percentage (%)
1.	Unutilized rainfed	7,527	7,368	-159	-2.11
2.	Temporary Unutilized rainfed	4,194	2,987	-1,207	-28.78
3.	Uncultivated Dry Land	114,297	86,753	-27,544	-24.10
4.	Paddock Grazing	111,500	108,555	-2,945	-2.64
	Total	237,518	205,663	-31,855	-13.41

Source: South Sulawesi Provincial Office of Food and Horticulture, 2011.

Table 1 illustrates the decrease in agricultural land around 13.41 per cent for three years or of 237.518 ha in 2007 to 205.663 in 2010. Land use is more widely used to plant corn, cocoa,

sugarcane including the activities of the agricultural development program. There still around 97,108 ha consisting of 10,355 ha of rice fields and 86,753 ha of dry land which are potency for cane development. Pasture land is a potency to convert into sugar cane for the development of household scale sugar cane industry and cattle development in an integrated manner without significant changing of the function pasture land. If the 25 percent land (205,663) is used for sugar cane development then there is about 51.4 thousand hectares with the average productivity cane is 70 tons/ha with 10 percent of sugar cane conversion factor of sugar cane production potency. The BCS produced is about 367.5 thousand tons or about 13 percent of national production or about 20 percent sugar imports can be substituted, and additional cattle that can be breed at least 500 thousand heads of cattle or about 50 percent cattle population in the South Sulawesi.

Human Resource Potency

BSC is a business that can be developed in small and medium-scale and very suitable to encourage the rural economy in Indonesia. BSC provide employment opportunities throughout the year, so the risk of food shortages for poor family is not supported with no regular income could be overcome. The development strategy of farmers with limited resources can be done with the development of integrated BSC-Cattle with low cost in the way that farming can provide higher revenues (Blanc, et al., 2004)

Large population and less optimal agricultural resource use generate an increase unemployment in agricultural sector. In contrast, the unemployment rate in the non-agricultural sector has decreased. The population of South Sulawesi in 2010 was 8,034,776 , approximately 3,272,365 employed and 298,952 unemployed, including open unemployment about 0.14 % of total population. There were increase the employment and decreased unemployment in 4.12 percent and -21.30 percent respectively the period of 2010-2012. labor force ec, with (BPS,2011; 2013). In the contrary, The number of people employed in the agricultural sector reduced about 123 thousand workers, i.e. from 1,592,299 workers in 2011 to be 1,469,325 workers in 2012; while other sectors have increased by about 2,2 thousand in the processing industry and around 60 thousand in trade, restaurant, accommodation, and services. GDRP (Gross Domestic Regional Product) for processing sector increased by about 6.10 percent and trade sector, hotels and restaurants 10.07 percent per year during the period 2005-2010.

Employment opportunities in the agricultural sector (including farming, forestry, and fisheries) increased by 50.9 thousand workers from 1,569,316 workers in 2009 to 1,620,177 workers in 2010. It is caused due to an increase in undertaking agricultural area of around 13.14 percent of the farming acreage coupled with processing of agricultural produce. BPS (2011) also reported that total female workforce in South Sulawesi reached 1,07 million people or 88 percent of total population in 2009 which was increased from 71.10 percent of total of female labor in 2005. The proportion of the female workforce was 47.9 percent in agriculture, 29.9 percent in the commercial sector, restaurants and accommodation services, and 12.3 percent in the service sector, community, social and personal. Female is a potential workforce for the

development of BCS-cattle production integration because many types of jobs are matched by female labor. This potential can be seen the great absorption of female labor in the agricultural sector (45.21%). Even in urban areas the majority of women workers are absorbed in the large commercial, retail, restaurants and hotels (47.33 %t) and social service sector (30.06 %). The particular interest is that the proportion of female workers absorbed in the processing industry tends to be higher than male employees, respectively 7.69 percent and 6.05 percent and that is good in urban areas or in rural area. Based on these data, there is a potential workforce to develop the BCS-cattle integration of around 1,289,419 people or about 35.4 percent of the work force available. Temporary employment opportunities that can be created with the expansion model is at least 150 thousand job opportunities. Cane-cattle integrated is an excellent economic activity because it can optimally utilize the unproductive agricultural land, develop livestock population, support the development of organic agriculture, create employment opportunities of around 2-3 people per hectare, reduce the level of poverty in rural, and empower women workers (Darma, et al., 2012).

Market Potential of BCS and Beef

Sugar is a strategic commodity in Indonesia's economy as belonging to the group of nine-basic needs for daily consumption. In 2010, total national sugar consumption both industrial and domestic consumption amounted to 4.55 million tons, while production was only 2.44 million tons of sugar (DGI, 2012). Shortage of sugar supply is met by importing sugar. In Table 1, it appears that national production is unable to meet the needs of overall consumption and so the government had to import sugar. Sugar consumption can not be matched by domestic sugar production due to several reasons, due to the decrease in sugar cane plantations because the land is converted to residential and industrial areas, the decline in yield, sugar prices continue to decline, and decrease sugar plant efficiency (Karmana, et al., 2012, Ariesa and Tinaprilla, 2012).

Table 2. Production, import, and domestic consumption of sugar (in million ton)

Year	Production	Import	Total Supply	Household Consumption	Industrial consumption	Total demand
2005	2.24	2.37	4.61	2.78	1.21	3.99
2006	2.31	1.71	4.02	3.08	1.22	4.30
2007	2.95	2.84	5.79	3.39	1.31	4.70
2008	2.57	2.04	4.61	3.83	1.51	5.34
2009	2.30	2.75	5.05	2.97	1.57	4.54
2010	2.24	2.91	5.15	2.86	1.69	4.55

Source: National Symposium of Sugar, Surabaya, Indonesia, 2012.

Sugar supply shortage will be met from brown sugar as one of the alternatives that can meet the needs of sugar in Indonesia (Akzar, 2012). The BCS potential market is magnified by

the food industry such as in East Java with the needs of 30-40 thousand tons per year, while the industries can only meet the production needs of about 5 thousand tons (Rosdiansyah, 2012). BCS has also export potential with the greatest demand from Canada, USA, Belgium, Australia, and Europe as the amount can reach 500 tones per month while the current BCS supply is only 30 to 50 tons per month (Akzar, 2012). East Java province has a sugar manufactory, owned by Ahmad Rubai, who has become the sole producer and exporter of raw sugar to Japan since 1995. Rubai exports BCS as much as 300 tons per year with a turnover of Rp. 15 M per year. Japan uses BCS as raw material for industrial syrup, ketchup, and cake (Astuti, 2009).

On the other hand, annual beef consumption per capita of Indonesia has reached 1.87 kg. This figure is low when compared to other countries in Southeast Asia. Low consumption even then, Indonesia needs at least 448,000 tons of beef or million equivalent 4.48 million of cows per year with 100 kg of average per cow. From these, only about 85 percent of which can be met by domestic beef production and the remaining, approximately 15 percent, was derived from imports. Based on these data, the number of additional cattle needed is about 672 thousand of cows which can be met from the increase of cattle population in South Sulawesi and import. Cattle population in South Sulawesi can be improved about 500 thousand head through the development of BCS-cattle integration of production or approximately 74.4 percent of the total shortage of meat in Indonesia.

Development of Brown Cane Sugar

Processing of cane into BCS be considered as a new economic activity known by farmers, especially in the area of cane sugar factories in South Sulawesi. Farmers are presently interested in planting sugar cane for the production of not only sold to sugar cane factories, but also processed to BSC and integratedly with cattle. There is renewed interest in reintegrating crops and livestock because of concerns about natural resource degradation, the profitability and stability of farm income, long-term sustainability, and fostering diversified cropping systems (Russele, et al., 2007; Crews, 2001; Cooper and Gamon, 1991).

In general, cane plantation is developed in South Sulawesi on marginal land with limited water availability. BSC-cattle production integration is one form of farm management with limited water in order to utilize the limited land resources or marginal land. Improving the effectiveness of land resources with limited water resources requires knowledge of good water management practices (Word et al, 2013)

Sugar cane in South Sulawesi has huge potency to develop based on the availability of land, suitable climate and sugar cane cultivation techniques that are well known by the farmer. Can has long been cultivated in the cane planting area of three factories in South Sulawesi. Over the last two years, the total cane area of three sugar cane mills have increased about 5 percent. The increase occurred in the dominance of *PG-Takalar* (Takalar Sugar Factory while both *PG-Bone* (Bone Sugar Factory) and *PG-Camming* (Camming Sugar Factory) decreased respectively 0.60 and 5.43 percent. This is because the three sugar mills suffered losses.

Planting area of sugar cane at the three plants showed a significant increase of around 17.84% from 2010 to 2011 due to the development of cane plantations has occurred in people's cane farm which is support by government programs in order to increase of the domestic production of sugar and reduce sugar imports.

Table 3.The cane area on the region of three sugar cane factories in South Sulawesi, 2010-2011 (in ha basis)

No.	Factories /Acquisition Land	2010	2011	Change	%
I.	***PG-Takalar***	***3,276.68***	***4,186.03***	***909.35***	27.75
	- Cane of Factory	2,376.68	3,118.49	741.81	31.21
	- Cane of Farmer	900.00	1,067.54	167.54	18.62
II.	***PG-Bone***	***3,822.30***	***3,799.19***	***-23.11***	-0.60
	- Cane of Factory	3,822.30	3,743.49	-78.81	-2.06
	- Cane of Farmer	0.00	55.7	55.70	100.00
III.	***PG-Camming***	***5,197.44***	***4,914.99***	***-282.45***	-5.43
	- Cane of Factory	4,253.22	3,864.99	-388.23	-9.13
	- Cane of Farmer	944.22	1,050.00	105.78	11.20
IV.	**Total**	**10,196.42**	**12,900.21**	**2,703.79**	26.52
	- Cane of Factory	8,352.20	10,726.97	2,374.77	28.43
	- Cane of Farmer	1,844.22	2,173.24	329.02	17.84

Sources: South Sulawesi Provincial Office of Plantation, 2012.

Table 3 described that the total area of cane for the three plants in South Sulawesi increased from 10,196.42 ha's in 2010 to12,900 ha's in 2011. This increase comprised of 28.43 percent and 17.84 percent of the sugar cane factories concession and farmer respectively. The development of sugarcane area owned by farmers is financed by National Development Budget (*APBN-Anggaran dan Pendapatan Belanja Negara*), the credits of food security and energy (*KKPE-Kredit Ketahanan Pangan dan Energy*) from BRI Bank, Partnership Program for Environmental Development (*PKBL-Program Kemitraan Bina Lingkungan*) from PTPN-X company. Although an increase in sugarcane acreage, the milling period of the three sugarcane factories was brief due to limited availability of cane as raw materials. Sugarcane acreage is around 13 thousand hectare and an average productivity of 60 tones of cane per hectare and milling capacity 2,500 TCD (tones can day), so that the production processing period of three plants is only about 70-90 days per year, which should be in normally around 150-180 days per year. Development of BCS could encourage farmers to grow sugar cane and then produce cane to BSC or sold to sugar factories.

Cattle Development Potency

Raising cattle is a way of life for most of the farmers in the South Sulawesi region and serves as a source of additional income and some the main source of income. Various innovations are also carried out by farmers, such as the development of collective cages to streamline workforce secure needs, livestock waste collection that can be converted into organic fertilizer and biogas (Darma, et.al, 2012). Integrated BCS-cattle production is one of the important farm model, generating benefits, creating employment opportunities in rural areas, attracting the labor force to work in the agricultural sector where urban-oriented looking for work is predominant for rural labor force. Various forms of employment in non-agricultural sector are not attractive because it has a lot of farm or rural business sector has turned into a profitable business (Darma and Arsyad, 2010; Ellis, 1998; 2000).

Cattle had good prospects and opportunities to develop as a competitive advantage in South Sulawesi. It is supported by the labor input cost components which are relatively cheap, huge non cultivated agricultural land, and culture in breed cattle. Carrying capacity of the dry matter crop waste as animal feed amounted to 25,807 million of livestock in South Sulawesi on 2006 (BPS, 2010).

Table 4. Cow Population Development in South Sulawesi (2007-2010)

No.	Year	Beef cattle	Dairy cows	Total
1.	2007	666,662	1,867	668,529
2.	2008	703,303	1,919	705,222
3.	2009	769,066	1,826	770,892
4.	2010	848,916	2,198	851,114
5.	2011	1,021,110	1,894	1,023,004
	Growth (%)	11.38	1.12	11.35

Source: South Sulawesi Statistical Livestock, 2011.

Over the last five years (2007-2011), the beef population growth in South Sulawesi increased about 11.35 percent per year. This happens because the cow is a commodity and development priorities of the provincial government of South Sulawesi. Various forms of financial assistance were provided by the government, such as the financing for the development of cattle which shall returned to the participating banks for revolving to another farmers. Revolving fund financing is given to sugarcane farmers through Cane Farmer Group (*KPT-Kelompok Petani Tebu Rakyat*) distributed by BRI bank.

BPS (2011) reported that the population of cattle in South Sulawesi has reached one million head in 2011 which is a fantastic figure, as it is faster than planned, which was targeted one million in 2013. Districts of Bone, Wajo, and Barru are cattle development centers in South

Sulawesi, so the proportion of the cattle population of about 40 percent of the total population of cattle in South Sulawesi, or 60 percent of the cattle population is spread in 19 districts in South Sulawesi. The density of population in the two districts of Bone and Barru is very high, respectively 20.73 and 22.68 heads per hectare, while the average cattle density for the South Sulawesi was 5.23 heads per hectare and other areas only 3.74 heads per hectare. This figure shows that the development of an integrated BCS-cattle production in the two districts should be promoted, because the cattle is a main business for most of the famer community in both regions.

Cattle, with the utilization of agricultural waste, and the intensive stall system, are the form of farming activities that can support the development of integrated sugar cane-cattle farming system. Cattle has grown mostly by farmers in South Sulawesi with farm system from the traditional grazing system to the system supported by intensive stall with particular grass grown. There are farmers who use agricultural waste from grain and fodder crops as the forage sources, but in small quantities.

Table 5. Number of Respondents (advanced farmers) in three districts based on rice farming and livestock cultivated

No.	Farm Classifications	District of Barru (n=30)	District of Wajo (n=25)	District of Bone (n=20)
I	**Commodity**			
	Paddy	76.6 %	60.0 %	90.0 %
	Crops	20.0 %	60.0 %	75.0 %
	Bulrush	36.6 %	-	62.5 %
	Cane	-	30.0%	82.5 %
	Cattle	86.3%	25.0%	62.5%
II	**Cattle Farming**			
	Range of Ownership (head)	2-14	2-25	5-25
	Average of Ownership (head)	6.5	8.8	7.0
	Farmers as Agricultural Waste Users	80.0%	15.0%	62.5%
	Intensive Cage	3.3%	5.0%	37.5%
	Seller of Manure	10.0%	25.0%	-

Sources: Primary Data, 2012.

Farmers who cultivate paddy, crops, and cattle were on the three location study, but forage and sugar cane cultivation has not been done in all areas. Cattle management systems differ among the three areas. Cultivation of forage and agricultural waste utilization were correlated with cattle management development in the Districts of Bone and Barru.

There is great potential area for the development of an integrated BCS-cattle in the three study sites, Barru, Wajo, and Bone districts. Communities in Wajo district were the first to know or to process cane into brown sugar, but this business was not growing because it was not

supported by processing technology. Cattle business is also done by some farmers, but more in the form of grazing system. Semi-intensive or intensive systems have been introduced by the government, but was not well responded to the community. The farmers do not use specifically fodder or using agricultural waste, so that the cattle business is still a secondary enterprise, even though Wajo district is one of Bali cattle development centers in South Sulawesi.

Cattle, especially Bali cows is the traditional business or culture for most farmers and growers as well as the main business, so Barru district is one of Bali cattle development centers in South Sulawesi as well as for germplasm preservation of Bali cattle in Indonesia. Cows are breed by semi-intensive and intensive systems. Semi-intensive is done by using natural sources of feed in the form of forage that grows wild and agricultural waste such as straw, corn stalks, and other crops, while intensive culture is practiced by using a source of food from the cultivation of elephant grass *(orchard grass)*, hay, manure processing, and urine processing for organic fertilizers. Farmers in Barru district are not familiar with cane plant that can be processed into sugar and as a forage source for cattle. Almost rancher in Barru is raising cattle between 5-10 heads. It can be said that every 5 cows can provide employment opportunities for around 1 person. Cow manure and biogas are utilized in this area. Feces as manure is sold at Rp500/kg, while the urine is processed to liquid fertilizer product, but the concentration and effectiveness of urine use is not known yet by farmers. Cultivation of sugar cane to crystals sugar has been well known by farmers in the district of Bone since the 1960s, when PG Bone was built. However, the BCS processing technique has not been widely known by sugar cane growers in this area, including the top of the cane has not been use extensively as a source of green to feed livestock. This happens because sugar harvest is conducted once in a year during milling period of sugar factory causing time availability of sugar cane tops as cattle forage food source is very short, so it was not a concern by ranchers.

District of Bone is also a center for cattle development in South Sulawesi with the largest cattle population among districts in South Sulawesi. Cattle, especially Bali cows, is a traditional livestock or breed by most farmers and growers as well as the main business, so the cows is cultured by semi-intensive and intensive system. Semi-intensive is done by using natural sources of food in the form of forage that grows wild and agricultural waste such as straw, corn stalks, and other crops, while intensive culture is conducted by using food sources of yield grass farming (orchard grass) and hay.

Appropriate Technology for BCS-Cattles Integration

Cattle, agricultural waste utilization, and intensive stall system is a form of agricultural activity that can support the integration of sugarcane farm and livestock. BCS could be produced easily by routinely harvesting of sugarcane and followed by the growth of new shoots that can be harvested as puppies after at least nine months old. Sugarcane can be harvested every day in for 7-8 months in a year, or during the off-season of rain. Household farmers can harvest 0.5 to 1 ton per day or depending on the cultivated sugar cane area. Taking in account the nature of this

crop, sugar cane shoot leaves as a waste can be used as fodder. In addition, there is the molasses as waste produced during in the process of cooking cane juice into BCS. Molasses is considered as an excellent mixture of cow's feed.

The processing of BCS is an appropriate technology (AT), using sugar cane juice machine that can be manufactured locally and powered by an engine of 8-12 HP (Horse Power), and complemented with a stove cooking using pans lined with 4-6 units for each stove. The processing capacity is about 2 tons of cane per day. AT-BCS is fuelled efficient because the bagasse produced from sugar cane juices as an energy source which is enough to cook the sap of sugar cane to the BSC. BCS-cattle integration production can be developed locally with a small amount of investment and support the development of intensive stall integration with bio digester which is an AT that has been well known to the rural community, but has not been developed because it is not supported by the availability of adequate forage to grow cow. Economies of scale integration of both ATs can be reached easily and provide enormous impacts to the economic, social, and environmental aspects. BSC increases employment opportunities in the agricultural sector and farmers' income, and simultaneously boost employment opportunities outside the agricultural sector. The development of employment opportunities outside the agricultural sector associated with the BSC will encourage rural and regional economic development. The creating new rural agricultural employment has positively influence the growing of non-agricultural sector (Brazil and Bukenya, 2012). This contrasts with other regions, where the business linkages of agriculture and non-agricultural sectors lowers farm incomes, especially for small-scale farmers who, because of lack of land or capital, are engaging in non-farm employment to supplement farm incomes (ADB, 2003).

BCS will encourage the development of the cattle population growth both in grassland-based and fattening system. This is based on the information that the potential of cattle weight gain increase from about 0.25 percent of body weight by giving 10% of forage or 3 percent of dry matter/concentrated of body weight. This means that every one kg of concentrate can converted in 0.025 kg of meat per day. The potential of Bali cattle weight gain is in average of at least 0.25 kg per day of 100 kg cattle weight. This weight gain was lower when compared with some other research which were 0.2-0.3 kg /day with a traditional culture, 0.35 kg /day by supplementing forage, and 0.42 kg / day with forage and concentrate (Sugana and Budiardi, 2012). Intuitively, the farmer could produce best feed from the mixture of the old leaves, shoot leaves, molasses, and sugarcane juice foam. If the price of beef is Rp 80,000/kg or equivalent to Rp 48,000/kg of price live-weight (60% of the price of meat), it means that farmers can receive a minimum of Rp_12,000/day of additional cow weight (0.25 kg x Rp 48,000/kg live weight).

Integrated BSC-cattle farming is a system highly efficient and environmentally friendly. This system can reduce nutrient leaching process in the soil of farm because tillage activities are not carried out, while older leaves of sugarcane used as mulch to reduce nutrient leaching during rainy season. Leaching of N in sugarcane is difficult to avoid given the absence of cover crops, especially during the rainy season (Shoko Ishikawa, 2014). Potential cane shoots are 30 percent of the production of sugarcane and old leaves make up 10 percent which is equivalent to about

40 percent of food biomass. When considering about 80-90 tones of sugarcane production, the total weight of biomass production make up approximately 125-140 tones/ha/year which consists of sugar cane, shoots leaves, and old leaves. Potential old and shoots leaves are available for harvest (200 days) and, about 150-200 kg per day or to meet the needs of 8-10 cows heads per hectare during harvest period. BCS and cattle development in an integrated manner could provide a workforce of about 3 people per hectare. Problems faced by farmers is the provision of additional feed for a minimum of 20 percent forage and additional labor for bagasse fermentation to overcome lignin content. It is recommended that the use of sugarcane shoots and leaves should not exceed 8 per cent of the live weight of cattle and a high content of lignin must be fermented (Andajani, 2011). Another problem also occurs because the BCS-cattle production integration still needs investment to build processing and sugar cane plantations where its value is relatively large for most farmers, not only in South Sulawesi, but also in Indonesia in general. This concept is difficult to develop quickly if there is no serious support from the government.

Conclusion and Recommendations

When BCS-cattle integration scenarios developed, household scale of BCS industries are also growing with some potential and prospects such as 1) brown sugar product can be marketed in the form of crystal brown sugar (*palm suiker*) which are often found in hotels and as raw materials for food industries; 2) BCS can also be developed as an export commodity in great demand abroad because less or no chemical contain; 3) The BCS-cattle production integration will boost as an alternative income source of farmer and will promote the utilization of agricultural wastes as alternative sources of income; and 4) it is expected in the future that there will be a processing technology that converts BCS to white crystal sugar, so the raw material for crystal sugar factory is the BCS produced by big amount of cane farmers and the white crystal sugar factories could be operated along the years or it is not depended to the season as well as conventional crystal sugar factories.

BCS-cattle production integration is an alternative concept for rural development and sustainable development in South Sulawesi. There is a great potential for cultivated farm land of around 302,771 ha that can be used for the development and BCS-cattle integration. This occurs because of the cow is a culture and a major source of income for most residents in rural areas and can be improved through the integration of processing BCS. Meanwhile, the development of BCS-cattle integration creates employment opportunities for 3 people per hectare, promotes sugar and meat import substitution, permit biogas as an alternative household energy source, as well as organic fertilizers that encourage environmentally friendly farming.

The government support is expected to make a pilot on each area and involving advanced farmers considered as early adaptors to develop BCS-cattle production integration while encourage other farmers to be followers.

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