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A Review of Integrated Cattle Oil Palm Production in Malaysia, Papua New Guinea and Indonesia*

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Abstract

Indonesia is the world's largest oil palm producer and has the potential to increase cattle production through integrated cattle oil palm production (ICOP) and to reduce the reliance on live cattle and beef imports from overseas. However, there are challenges that could dampen the achievement of that potential. This paper presents the results from a review of literature on ICOP that has been implemented in Malaysia, Papua New Guinea, and Indonesia, as well as from field work conducted in Riau province, the largest palm oil producer in Indonesia. Major constraints to adoption facing companies are: additional investments required to professionally manage the production and marketing of cattle, an unstable beef market, relatively low profitability from cattle farming, the lack of infrastructure to support an efficient cattle/beef supply chain, and concerns over soil compaction and the spread of Ganoderma disease. One key finding from this study is that ICOP may be more applicable to smallholders because, to varying degrees, their mixed farming systems are already integrated and cattle sales can increase income substantially. Secondly, the environmental benefit from ICOP, particularly in terms of reductions in herbicide and synthetic fertiliser use, seems to be more clear-cut than financial benefits/returns, which depend largely on management, markets and the policy settings. Therefore, greener business models that place more or equal emphasis on both financial and environmental benefits warrant serious consideration by both policymakers and the private sector. The greener approach will also lend support to sustainable oil palm initiatives.

Key words: cattle-oil palm integration, ICOP, RSPO, beef self-sufficiency, Indonesia

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Introduction

Demand for beef in Indonesia has been increasing due to population growth, increasing income and urbanisation. However, domestic beef supply has not kept up with demand and nearly 50 per cent of beef requirements are met by beef and live cattle imports (Agus and Widi, 2018). Being the world's largest palm oil producer, integrated cattle-oil palm production (ICOP) is seen by the Government of Indonesia as part of the solution for increasing domestic beef supply and reducing the reliance on imports (Sudaryanto, 2017). ICOP, based on the principle of energy and nutrient recycling, makes good intuitive sense. In particular, the biomass and by-products from the oil palm plantation will help address issues of feed scarcity, which is the most limiting factor for increasing cattle production in areas that face a long, dry season, such as eastern Indonesia.

Despite the many potential benefits from ICOP and promotion by governments, its adoption has been limited in Malaysia and Indonesia, both by companies or smallholders. The objectives of this paper are to identify the constraints and opportunities for ICOP and to make recommendations for the way forward. The analysis is based on desktop research and field work. Desktop research focuses on reviewing the literature from Malaysia because that is where most research, both technical and institutional, on ICOP has been conducted. Those results and lessons learned can serve as a basis for further research and policy development for Indonesia because of similar operating environments. The latter includes both countries being leading palm oil producers, both facing severe beef shortages, and both governments pushing for ICOP to meet beef self-sufficiency policy objectives. Field work is conducted in Riau province, the leading oil palm producer in Indonesia.

ICOP in Papua New Guinea is included in the analysis because it is a private company initiative, and commercially-driven, as opposed to being pushed by government policies; consequences associated with this basic difference in policy context may be informative.

A map of oil palm producing areas in Indonesia and Malaysia is shown in Figure 1.

Figure 1. Oil palm producing areas in Indonesia and Malaysia

Source: Dance (n.d.)

In this paper, results from the literature review are presented first, followed by results from the field work. Lessons learned, and opportunities and constraints identified for developing and promoting cattle-palm integration in Indonesia, are then discussed. The paper ends with some concluding remarks.

Method

The methods used in this paper included the following:

- Desktop research to review existing ICOP systems in Malaysia, Papua New Guinea and Indonesia, focusing on the production system, financial and biological performance, government policies, and issues and constraints;
- Field work based on stakeholder consultations and informant interviews to understand beef cattle production systems and beef market chains in Riau, as well as issues and constraints; and
- Collection and analysis of secondary data.

Field work was conducted in Riau province in July 2017, and in October 2018 and October 2019, based on semi-structured questionnaires. Informants interviewed included: farmer group leaders (6), a plantation manager (1), cattle traders (3), slaughterhouse operators (3), butchers/beef retailers (3), meat distributors (3), and supermarket managers (2). Meetings and consultations were also held with government agencies (Dinas of Livestock and Animal Health and Assessment Institute for Agricultural Technology (BPTP) in Riau province) to understand the policy settings, and their views on, and experiences with, ICOP, as well as to collect data at the local level.

What is Integrated Cattle Oil Palm Production?

The basic concept of ICOP is to cycle the energy and nutrients between oil palm and cattle so that, together, more benefits are generated than if they are operated separately. Energy and nutrient recycling between palm and beef cattle occurs when the palm plantation provides feed for cattle while the cattle provide weeding services and organic fertiliser to the palm trees (IACCB, 2020).

Some 2-3 hectares of oil palm area is generally required to support one head of cattle per year when it is based solely on grazing (Latif and Mamat, 2002). Carrying capacity or stocking rate can be increased if palm fronds and leaves and by-products from oil palm processing, such as palm oil sludge and palm kernel cake, are also utilised to supplement forage intake. Also, regular organic fertiliser application to palm trees can increase palm yield while feeding cattle with the biomass and by-products can reduce input cost, and together they can generate more income over and above separate palm and cattle production (Devendra, 2011). Income from cattle, both meat and organic fertiliser sales, can provide an economic buffer in the highly volatile global commodity market when palm oil prices are reduced. Cattle- grazing under palm may also provide some environmental benefits from the reduction in the use of synthetic fertilisers, herbicides and pesticides on palm.

The concept of integration is not new (FAO, 2001). It is similar to mixed farming that has been practiced by subsistence farmers for generations. What is different may be the degree of complexity, scale of production and market orientation. Given that integration can vary in degrees, it is helpful to view the process of cattle-oil palm integration as a continuum, rather than a dichotomous choice. For example, at one end of the continuum there may be separate cattle and palm production while maintaining the exchange and utilisation of by-products from each. At the other end, cattle and palm are fully integrated, complementary and mutually supporting. It is clear that the higher the degree of integration and the larger the scale of operation, the more resource demanding it is. It is also clear that there is opportunity for a staged approach, moving from simple association towards full integration, depending on the resources and market conditions.

Oil Palm Production in Indonesia

Indonesia is the world's largest palm oil producer, followed by Malaysia. It accounts for 60 per cent of total global production and 1.5-2.5 per cent of Indonesia's GDP (Indonesia Investments, 2017). Demand for palm oil has grown significantly in past decades because of the rising demand for food and cosmetic products that use palm oil as an ingredient, as well as the use of biofuel encouraged by various governments across the globe. Driven by increased global demand, oil palm cultivation has been expanded significantly in Indonesia by smallholder farmers and conglomerates alike. In 2016, total palm oil production was 31.5 million tonnes, of which 25.1 million tonnes were exported, generating USD$17.8 billion in export earnings (last column, Table 1). Few Indonesian industries have shown such robust growth as the palm oil industry during the past 20 years.

Table 1. **Indonesian palm oil production and export statistics, 2010-2016**

	2010	2011	2012	2013	2014	2015	2016
Production (in million tonnes)	21.8	23.5	26.5	30.0	31.5	32.5	31.5
Export (in million tonnes)	17.1	17.6	18.2	22.4	21.7	26.4	25.1
Export Value (in US$ billion)	16.4	20.2	21.6	20.6	21.1	16.5	17.8

Source: Indonesia Investments (2017)

The most important export destinations are China, India, Pakistan, Malaysia and the Netherlands. Although the majority of Indonesian palm oil (80 per cent of total production) is exported, domestic palm oil demand in Indonesia is growing due to Indonesia's growing population, rapidly expanding middle class and the government's support for biodiesel production (Indonesia Investments, 2017).

However, the rapid growth in the Indonesian oil palm industry has come at the expense of the environment, as well as other agricultural commodities (Carlson et al., 2018). On the one hand, the conversion of forests, peatland and diverse forest gardens has led to a loss in biological diversity and higher greenhouse gas emissions, among other impacts. On the other hand, the conversion of food and subsistence crops, such as rice, and other cash crops (such as cocoa, coffee, and rubber), to oil palm due to its relatively high profitability can lessen food security and increase the vulnerability of smallholders to market fluctuations. Oil palm development also has been linked to the displacement of local indigenous populations and the destruction of their livelihoods. These environmental and social issues are recognised by the government and the industry, and some measures have been taken, such as tighter control on land conversion, and the support for the Roundtable on Sustainable Palm Oil (RSPO)[1] and the Indonesia's Sustainable Palm Oil (ISPO)[2] initiatives.

[1] The Roundtable on Sustainable Palm Oil (RSPO), a voluntary certification scheme, was founded in 2004 in response to the call for sustainable palm oil production. The objective is to promote the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders. RSPO can also help improve palm productivity for smallholders by including Good Agricultural Practices in the

Oil palm industry structure in Indonesia

Oil palm plantations in Indonesia are classified into three categories based on ownership: (i) smallholders that occupy less than 25 ha of land; (ii) state-owned enterprises, and (iii) private estate companies. In 2015, of a total plantation area of 11.30 million ha, private companies had the largest share (52 per cent), followed by smallholder farms (41 per cent) and state-owned enterprises (7 per cent) (Sudaryanto, 2017) (Table 2). In terms of the scale of production, most smallholders own 2-3 ha of oil palm while large companies, approximately 1,500 of them in Indonesia, own on average 40,000 ha per company. One of the top palm oil companies, Astra Agro Lestari Tbk PT, has nearly 300,000 ha. As can be seen in Table 2, the total oil palm area was 5.3 million ha in 2004, but had increased to 11.3 million ha in 2015. In 2006 alone, the area increased by more than 20 per cent.

Table 2. **Areas of palm oil plantation based on the type of ownership (000 ha)**

Year	Type of ownership			Total	Rate of change (%)
	Smallholder	State-owned	Private		
2004	2 220.3	605.9	2 485.5	5 284.7	
2005	2 356.9	529.9	2 567.1	5 453.8	3.20
2006	2 549.6	687.4	3 357.9	6 594.9	20.92
2007	2 752.2	606.2	3 408.4	6 766.8	2.61
2008	2 881.9	603.0	3 879.0	7 363.8	8.82
2009	3 061.4	630.5	4 181.4	7 873.3	6.92
2010	3 387.3	631.5	4 366.6	8 385.4	6.50
2011	3 752.5	678.4	4 562.0	8 992.8	7.24
2012	4 137.6	683.2	4 751.9	9 572.7	6.45
2013	4 356.1	727.8	5 381.2	10 465.0	9.32
2014	4 422.4	729.0	5 603.4	10 754.8	2.77
2015	4 575.1	750.2	5 975.1	11 300.4	5.07

Source: Sudaryanto (2017)

Most of Indonesia's oil palm plantations are located on Sumatra and Kalimantan islands in the regions shown in Table 3. Together, they accounted for 77 per cent of total oil palm plantation areas in Indonesia in 2013.

As can be seen from Table 3 (bottom row), smallholders accounted for 42 per cent of total oil palm planting areas, involving 1.46 million households. This means successful interventions in ICOP can potentially have a significant impact on the livelihoods of many people. However, the average palm area per household is small. On average, each household owns 2.1 ha of oil palm plantations. Since research has suggested a stocking rate of at least 2-3 ha per head, the small landholding means involving smallholders in ICOP may be limited without improving their access to plantations of others, be they other smallholders or companies.

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certification process. Around 20 per cent of global palm oil production was certified by RSPO in 2020 (RSPO, 2020). 2.174 million ha (out of a total of 14 million ha) of oil palm area in Indonesia is certified by RSPO.

[2] Indonesia's Sustainable Palm Oil System (ISPO) was introduced by the Indonesian government in 2011. It is a mandatory certification scheme which aims at ensuring that respect for the environment, workers and local populations is applied to all palm oil producers. The ISPO Commission has certified 502 oil palm plantations, covering 4.11 million ha of area, which accounts for nearly 30 per cent of Indonesia's estimated 14 million ha of palm plantation (Reuters, 2019).

Table 3. Smallholder involvement in Indonesian oil palm industry, 2013

Province	Total area (000 ha)[1]	Smallholder area (000 ha)[1]	Smallholder share (%)[1]	Smallholder area (000 ha)[2]	No. of HH** (000 head)[2]	Acreage/ HH (ha)[2]
Riau	2,227	1,363	61	879	308	2.9
N. Sumatra	1,276	431	34	527	333	1.6
C. Kalimantan	1,168	181	16	115	41	2.8
W. Kalimantan	955	333	35	194	70	2.8
S. Sumatra	941	402	43	196	77	2.6
E. Kalimantan	829	239	29	107	38	2.8
Jambi	721	446	62	332	126	2.6
Sub total	8,117	3,395	42	2,350	993	2.4
National total	10,586	4,416	42	3,134	1,458	2.1

Source: Daemeter Consulting (2015). *Notes*: [1] Based on BPS Annual 2013 statistics; [2] Based on BPS 2013 Agricultural Census.

Smallholder oil palm production

Basically, there are two ways by which smallholder oil palm plantations can be established. Being a "plasma" farmer linked to a "nucleus estate and outgrower scheme" (NES) is one, or being independent from such a scheme (Daemeter Consulting, 2015). NES is a common model for involving smallholders in tea, coffee, rubber, and oil palm plantations. NES was first promoted by the World Bank in the 1960s to engage smallholders in plantation operation (Daemeter Consulting, 2015). The NES program, introduced to Indonesia by the World Bank in 1977, is known locally as PIR-BUN (*Perusahaan Inti Rakyat - Berbantuan)*[3]. It aimed at "mobilising the expertise of state-owned estate companies to help landless and poor settlers from areas surrounding the project in establishing smallholdings on unexploited land". The state-owned estate companies in this approach were referred to as the PT Perkebunan Nusantara (PTPN). The role of oil palm became more predominant in subsequent NES projects in the 1980s. Under NES, the estate company typically provides fertiliser, training, extension support and other services to its plasma farmers, with a formal off-take agreement obliging farmers to deliver all their fresh fruit bunches (FFB) production to the company's mills.

Overtime, the funding model, the participants, and management structure associated with NES have evolved. Firstly, NES is now funded by the Indonesian government or private companies, or jointly by both. Secondly, NES is operated as part of a transmigration scheme (PIR-TRANS), rather than just for local people. Thirdly, while under the old NES schemes (PIR-BUN and PIR-TRANS) smallholders manage their own plots, under the new scheme (PIR-KKPA), smallholder plots are managed by the estate company via the Village Unit Cooperative, or *Koperasi Unit Desa* (KUD), the so-called one-roof management system.

Another management model that has become popular in recent years is the investor model, whereby the landowners are effectively shareholders/investors and receive a dividend/regular

[3] The Nucleus Estate Scheme (NES) is translated into Indonesian as Perusahaan Inti Rakyat (PIR). The NES program was officially called PIR Berbantuan (or PIR-BUN), which can be translated as "PIR programs supported by foreign donors".

payment for their stake in the plantation. They are not involved in managing their own plots, except as a hired labourer.

Smallholder farmers who are not linked to a company can be organised as a member of a farmer group or a cooperative. In a farmer group, farmer members still manage their own individual plots and join forces to market FFB, as well as to meet certification requirements or to access training, fertiliser or finance. In a cooperative, contiguous plots of land may be managed jointly by the members, in addition to marketing FFB together. There may be additional benefits to being a cooperative member, such as building a replanting fund through member contributions or a reserve fund to guarantee minimum incomes to members in years of low yield or low prices.

There are also farmers that are not linked to any scheme or group. Although most of these independent farmers are small, typically managing a 2-5 ha parcel of land, some may be managing plantations greater than 10 ha, and often up to hundreds of hectares. The latter may employ other farmers to help manage their plantations and may also act as a local agent or local trader for smallholders.

The industry/management structure just described has important implications for ICOP development because they represent the potential business models whereby ICOP can be implemented. Some of these models may be more, or less, conducive to the concept of ICOP since they differ in terms of autonomy, motivation, the scale of operation, resource endowment, access to services, productivity, and financial performance. For example, the so-called one-roof management system under NES looks quite promising, whereby plasma farmer plots are managed by the company via the Village Unit Cooperative, which has access to technical assistance, market, and green feed from the company, and by-products from the mills. The cooperative model also has potential if they can be supported by government or NGOs.

Cattle Production in Indonesia

In Indonesia, 90 per cent of cattle production is from smallholder farming systems involving about 6.5 million farmers living in rural areas, and the remaining 10 per cent is from specialised commercial operators, including commercial farmers (less than 1 per cent of all farmers) and feedlots (Agus and Widi, 2018). Normally, smallholder cattle farmers own 2-3 cattle per household.

In Indonesia, smallholder cattle production systems are often categorised by the type of output for which cattle are being raised (weaners or feeder cattle from a cow-calf operation, slaughter cattle from a cattle-fattening enterprise, or a mixed cow-calf and fattening operation). They are also categorised by how cattle are being fed or managed (intensive, extensive, or semi-intensive). There are some variations in the feeding system, depending primarily on the degree of specialisation and the scale of operation. For example, there is controlled grazing within the extensive feeding system and lot-feeding within the intensive feeding system.

Five basic cattle production systems, as described in Waldron et al. (2013) and Agus and Widi (2018), are outlined below:

- Intensive: In an intensive production system, cattle are kept in the barn or pen (kandang) the whole time and forages are cut and carried to feed the cattle. It is labour-intensive, but has the advantages of keeping cattle safe from theft and accidents, and allowing animal health monitoring and disease treatment, controlled mating and the use of artificial insemination (AI), etc.

- Extensive/free range: In an extensive production system, cattle are allowed to graze freely and continuously in the grassland or in the plantation day and night, and without any control. The advantage of this system is low input, but it also tends to be low output and lacks the management advantages of an intensive system.
- Semi-intensive: This system is a mixture of the intensive and extensive systems, in which cattle graze, freely or tethered, in the field during the day, but are taken back and housed in the barn during the night. Normally, there is supplementary feeding while cattle are in the barn.
- Controlled/rotational grazing. Unlike the traditional method of free range/continuous grazing, in this system the grazing land is divided into several paddocks/blocks (e.g., 300-ha blocks), using portable fences, with or without electricity. Cattle are moved around from one paddock to the next, depending on a set schedule or feed availability. The advantage of this system is that it limits the harmful effect on the environment of overgrazing while increasing forage consumption by cattle. However, it requires planning and close observation.
- Lot feeding: Lot feeding is the most intensive form of cattle production where cattle are placed in enclosures of a small size to achieve maximum daily weight gain on a high protein diet. They are large-scale fattening operations, based mostly on feeder cattle imported from Australia. There are 43 feedlots in Indonesia, and they account for about 9-10 per cent of beef production in Indonesia (Agus and Widi, 2018). Most feedlots in Indonesia are large scale (1,000-12,000 head).

In Indonesia, mixed systems predominate. However, some smallholder farmers may specialise in a cow-calf or fattening operation. For example, in Sumbawa Island there are small-scale fattening units, so-called “household feedlot production”, with 2-20 head based on tree legumes, such as Leucanea (Panjaitan et al., 2014). In addition, there are farmer groups that focus on cow-calf operations, especially as a village breeding centre supported by government programs (Waldron et al., 2013).

While a cow-calf operation may be more cost effective in an extensive system, fattening is more productive in an intensive system. Some farmers prefer a cow-calf operation because of its lower demand on capital and feed, while other farmers prefer fattening because of its quick turnover (normally in 4-6 months) and higher profitability, especially when there is high demand for slaughter cattle around the national Islamic holidays, Idul Fitri and Idul Adha.

Another defining dimension of a cattle production system is breed because they differ in adaptability to agro-climatic conditions and in reproductive and growth performance. Therefore, cattle breed composition varies from region to region, depending on agro-climatic conditions and feed availability. In the 2011 Bovine Census, three main local cattle breeds were identified: Bali cattle, Madura and Ongole (Waldron et al., 2013). The remainder were exotic/imported breeds such as Brahmas, Limousin, Simmental, and their crosses. Bali, Ongole and crossbreeds each made up roughly 30 per cent of the Indonesian cattle population, with Madura accounting for the remainder (about 10 per cent). Increasingly, farmers across Indonesia are switching from local cattle and natural mating to crossbreeds with AI because of improvements in daily weight gain and slaughter weight. However, crossbreeds often experience problems in reproduction (e.g. difficulty in conception, calving, and re-conception after calving) (Agus and Widi, 2018).

ICOP in Malaysia

Malaysia is the world's second largest producer of palm oil, surpassed only by Indonesia. In 2017, Malaysia had 5.81 million ha of oil palm (MPOB, 2018). Around 61 per cent of these were owned by private companies and the remaining by joint ventures/state agencies (22.1 per cent) and smallholders (16.9 per cent). Like Indonesia, smallholders, defined as having an aggregate land of less than 40.46 ha, can either be independent or plasma farmers who are linked to a company, private or state-owned, under a NES scheme.

Malaysian government policy on ICOP

ICOP in Malaysia was stipulated in the National Agricultural Policy (1992–2010) (Zamri-Saad and Azhar, 2015). The main argument for promoting ICOP in Malaysia was to utilise as animal feed the vast amount of biomass produced at the plantations and the by-products from palm oil processing mills. In addition, cattle grazing can act as a biological control of weeds, and reduce chemical contamination. The initial plan or target of the National Agricultural Policy was to double domestic beef production from 9,500t in 2005 to 20,200t in 2010, and to have 1 million head of cattle grazing in 739,600 ha of oil palm plantation by 2015. It was further projected that when ICOP reached 2.2 million ha, it could trigger an expansion in beef production towards self-sufficiency. Unfortunately, currently those targets are far from being achieved. In 2013, nearly two thirds of total beef demand in Malaysian was met by imports, comprising mainly lower cost Indian buffalo meat (Ariff et al., 2015).

The National Policy on ICOP was implemented mainly by state-owned plantations, such as the Federal Land Development Authority (Felda), Federal Land Consolidation and Rehabilitation Authority (Felcra), ESPEK Plantations, and Rubber Industry Smallholders Development Authority (RISDA), as well as other state agriculture and land development institutions. The policy was supported, for more than a decade, by extensive research on both technical and financial issues, including productivity, profitability, and the feasibility of various ICOP production systems, the utilisation of oil palm by-products, both at the estate company and smallholder levels, and soil fertility and the threat of diseases. Some useful outputs are summarised below.

Impact of cattle grazing on palm production

Devendra (2011) and Zamri-Saad and Azhar (2015) provide a comprehensive review of ICOP from several countries in the past two decades. The main economic benefits reported from those studies are:

- Increases in animal production and income, with average daily gains of 0.48kg, 0.37kg and 0.15kg in the feedlot, semi-feedlot and free grazing systems, respectively;
- Increases in FFB yield and income, by about 30 per cent (between 0.49t and 3.52t/ha/year);
- Savings in weeding costs, by about 47-60 per cent; and
- Internal rate of return, at 19 per cent.

More details can be found in Table 4.

There are some environmental benefits associated with ICOP (Azid, 2004). Firstly, the use of cattle as a biological weed control mechanism in oil palm plantations reduces herbicides usage, which means less environmental contamination and pollution. Secondly, dung and urine contain beneficial nutrients such as nitrogen, phosphorus and potassium and, together with the organic matter, they

Table 4. The impact of ICOP on palm yield and weeding costs

Results	Authors
Increased yield of FFB by 0.49t/ha	Samsuddin (1991)
Savings in weeding costs by 20-40%	Chen and Harun (1994)
Savings in weeding costs by 17-38%, and IRR, at 25-50%	Latif and Mamat (2002)
Savings in weeing costs by 30-60%	Rosli and Nasir (1997)
Savings in weeding costs by 73%	Nasir (1998)
Savings in weeding costs were RM22/ha	Salim (2003)
Savings in weeding/herbicides costs were RM30/ha	Fadzil Mohammad (2003)
Increased yield of FFB by 30%	Chen et al. (2003)
Savings in weeding costs by 68.6%	Ongkah (2004)
Savings in weeding costs by 15-40%	Azi (2007)
Savings in weeding costs by 5-26%	Khan (2007)
Savings in weeding costs by 44-50%	Nasir et al. (2007)
Savings in field costs/yr by 30-40%	Zainudin (2007)
Savings in weeding costs by 15-28%	Kabul (2007)
Increased FFB/ha by 14.1%	Gabdo and Abdlatif (2013)
Savings in weeding cost by 21%	Ayo and Kabul (2012)

Source: Devendra (2011) and Zamri-Saad and Azhar (2015)

can help maintain soil structure and fertility. Thirdly, cattle grazing in oil palm plantations help increase biodiversity and maintain the soil ecosystem. This is because cattle dung can increase the number and variety of dung beetles which helps restore soil hydrological properties and fertility (Slade et al., 2014). Finally, oil palm provides habitats for insects and birds.

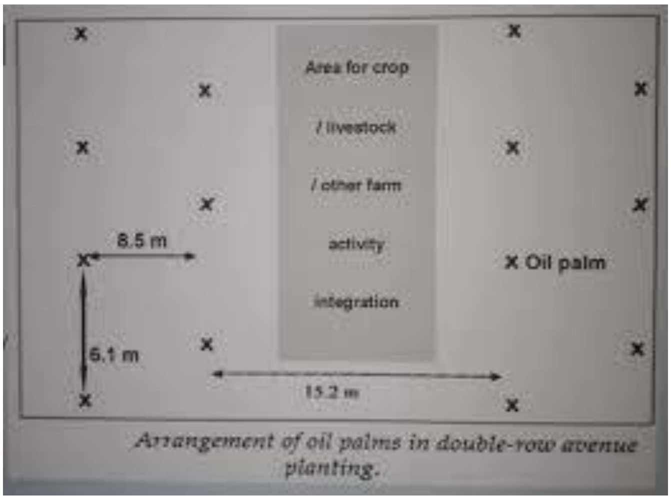
As can be seen from Table 4, savings in weeding costs is the most significant benefit from ICOP. However, it does not occur immediately. Rather, it normally takes two years for necessary changes in species colonisation to occur. In addition, research also found that the amount of grasses available under palm changes over time. It is very high in the first few years after planting, amounting to 2,000–3,000kg dry matter per ha per year. However, when the palms are six to 20 years old, the biomass declines substantially to between 400kg and 800kg dry matter per ha per year when the palm canopy starts to reduce sunlight penetration (Chen and Shamsudin, 1991). On average, the stocking rate was found to be three ha per head, ranging from 1.9ha to 3.7ha per head depending on forage availability and the type and age of cattle (Latif and Mamat, 2002). Feed supply can be increased and made more consistent with a Double Row Avenue Planting System (DRAS) (Tohiran et al., 2014).

In DRAS, oil palm is planted in two rows for every avenue, with the planting distances being 6.1m between the palms in the same row and 9.1m between rows, while the distance between two avenues is 15.2m (Figure 2). By comparison, planting distances of a normal triangular system are 9.1m x 9.1m x 9.1m. There are several advantages of the NHSS/DRAS system (MPOB, 2009), including:

- The system allows pasture and other crops to be planted in inter-rows;
- While large estates can practice rotational grazing, DRAS is also suitable for smallholders (<25 ha) operating an intensive system (cut and carry);
- Palm density in DRAS is 136 palms/ha, which is similar to the normal triangular system; and

- Where data are available, the average FFB yields are similar in both systems (15.38t/ha/year vs 15.28t/ha/year).

Figure 2. Double Row Avenue Planting system in oil palm



Source: MPOB (2009)

Utilisation of oil palm by-products

In addition to cattle grazing, a significant amount of ICOP research in Malaysia was devoted to the utilisation of by-products from oil palm plantations (oil palm fronds (OPF) and trucks (OPT)), and from the milling of palm fruits and the extraction of palm kernel oil. The latter includes palm kernel cake (PKC), palm oil sludge (POS), palm pressed fibre (PPF), empty fruit bunches (EFB), and decanter cake. In the early days, those by-products were discarded and posed a pollution problem to the environment. However, their potential uses as animal feed have been recognised. This is particularly true for PKC and POS. The nutritional contents and proximate composition of those by-products are shown in Table 5.

PKC, obtained after the extraction of palm kernel oil from the kernels of the oil palm fruits, is of particular interest because of its nutrient contents. It is classified as an energy-feed and its chemical composition is similar to copra meal, rice bran or corn gluten feed. With a CP content ranging from 14 – 18 per cent, PKC is sufficient to meet the protein requirement of most classes of ruminants.

Table 5. Mean chemical composition and nutritive value of oil palm by-products (in % DM, except for ME)

By-products	CP	CF	NDF	ADF	EE	Ash	ME
Palm kernel cake (PKC)	17.2	17.1	74.3	52.9	1.5	4.3	11.13
Palm oil sludge (POS)	12.5	20.1	63.0	51.8	11.7	19.5	8.37
Palm press fibre (PPF)	5.4	41.2	84.5	69.3	3.5	5.3	4.21
Oil palm fronds (OPF)	4.7	38.5	78.7	55.6	2.1	3.2	5.65
Oil palm trunks (OPT)	2.8	37.6	79.8	52.4	1.1	2.8	5.95
Empty fruit bunches (EFB)	3.7	48.8	81.8	61.6	3.2	NA	NA

Source: Alimon and Wan Zahari (2012). CP: Crude protein; CF: Crude fibre; NDF: Neutral-detergent fibre; ADF: Acid-detergent fibre; EE: Ether extract; ME: Metabolisable energy in MJ/kg

The mix of 50 per cent PKC, 30 per cent OPF and 20 per cent POS, for example, has been shown to produce a weight gain of 0.47-0.78kg/day, with acceptable meat quality in beef cattle (Alimon, 2004). Carcass analysis indicated that beef cuts were of superior quality when compared to those of cattle fed on grass or pasture.

In Malaysia, PKC is widely used as an ingredient in rations for feedlot cattle, dairy cows and buffaloes (Alimon and Wan Zahari, 2012). Recommended levels of PKC in livestock feeds are shown in Table 6.

Table 6. Recommended levels of PKC in livestock feeds

Species	Recommended level
Beef cattle	30-80%
Dairy cattle	20-50%
Sheep and goats	20-50%
Poultry - broiler	<10%
Poultry - layer	<10%
Swine	<20%
Freshwater fish	<10%

Source: Alimon (2004)

In Indonesia, on the other hand, access to PKC is one of the main issues facing smallholder cattle farmers. This is because either the palm oil mills do not process palm kernel or the PKC produced is exported to other provinces, such as East Java.

Concerns over soil compaction and Ganoderma

Research also was conducted to address the concerns from the plantation companies regarding perceived negative impacts of cattle grazing on palm production, such as soil compaction, decreased yield, increased fly and parasite populations, and the potential spread of Ganoderma[4] fungus (Devendra, 2011). Kok (2008), cited in Azid (2008), found that the impact of cattle on oil palm yield is insignificant, compared to other more prominent factors such as rainfall, soil fertility and operational efficiency. It was further noted that the notion of soil compaction due to cattle grazing was unfounded as grass regeneration after each grazing round was found to be rapid, luxuriant and complete (Rosli, 2000). No difference was found in soil compaction between integrated and non-integrated areas by Chen et al. (1996). In cases where soil compaction, loss of soil nutrients and decreased yields were found, they were not serious problems and could be addressed effectively by strategic cattle management (Tohiran et al., 2014).

Strategic cattle management

ICOP is not suitable for all plantations. Rather than simply putting cattle in the plantation, it must be carefully planned. *S*trategic insertion deals with the introduction of cattle into an oil palm estate operation (Ayob and Kabul, 2009). It starts with a "fact finding mission" to determine the suitability of the estate in adopting ICOP (Azid, 2007). Factors to be considered are: individual estate manager's understanding and commitment, availability and types of vegetation, carrying capacity, herd size and the timing of cattle introduction, and markets. Among these, the commitment of estate top

[4] Ganoderma is a disease caused by a fungus known as Ganoderma boninense that attacks the root system of oil palms. It was said that cattle grazing in the plantation can spread the disease, affecting yields and killing trees.

management is the prerequisite for successful cattle-oil palm integration. This commitment, and the understanding that many aspects of the palm production will require adjustments to accommodate the "additional" activity within the same area, must be established at the outset. In addition, sufficient funds have to be allocated for stock purchase and basic infrastructure establishment. Cattle are best introduced during the time when operational activity is minimal. At the operational level, the newly introduced cattle need to be "conditioned" for them to adjust to the new environment, especially for imported cattle, and exposed gradually to new feedstuff and feeding regimes. Strategic insertion will minimise the "stress period" for both people and animals and hence contribute positively to cattle performance.

Equally important is the application of strategic rotational grazing management, using mobile electrical fencing. It is a flexible and dynamic process by which cattle grazing in oil palm plantations can be adjusted to suit the operational requirements of the estate. Some of the key points are:

- Movement of cattle within the estate will need to be coordinated with estate agronomic practices, such as harvesting and fertiliser applications, to minimise "collision" when grazing cattle and estate activity arrive at the same spot; and
- The strategic rotational grazing management will require constant adjustment and modification according to prevailing estate operation.

Rotational grazing, when well-managed, can help improve savings in weeding costs (Azid, 2007) as well as reduce the potential problem of soil compaction (Tohiran et al., 2014).

Adoption and constraints to adoption of ICOP in Malaysia

Despite the potential benefits of, and the efforts to promote, ICOP, the response by major plantation companies in Malaysia has been lukewarm, and the adoption of ICOP has been minimal (Zamri-Saad and Azhar, 2015). As a result, the initial target, as stated in the National Policy, of having 1 million head of cattle on oil palm plantation by 2015 was far from being achieved. While 20 per cent of the total oil palm plantation area (about 4 million ha) was deemed suitable for cattle production, only 2.1 per cent has been used for integration with ruminants (Devendra, 2011). Companies that have been involved in livestock integration are mainly state-owned oil palm plantation companies (such as Felda, Felcra and RISDA) (Ismail and Wahab, 2014). Among them, Felda, the largest state-owned oil palm company in Malaysia, accounted for 69 per cent and 59 per cent of total cattle numbers under palm in 1997 and 2002, respectively. In 2006, in Peninsular Malaysia there were 1,279 smallholders raising 159,473 head of cattle on 422,581 ha of oil palm area in 26 districts, which accounted for 20 per cent of the total cattle population in Malaysia (around 806,000 in 2006) (Ariff et al., 2015). There appears to be no recent update on the extent of ICOP in Peninsular Malaysia.

In Sabah, the trial of ICOP began in 2005 at the Sawit Kinabalu Farm Products Sdn Bhd (SKFPSB) owned by the state government, with 10,000 head of cattle on 30,000ha of oil palm plantation (Azid, 2019). Due to replanting in 2007, ICOP was stopped and was not resumed until 2016. In 2019, there were nearly 15,000 head of cattle on 32,572ha of grazing land (see Table 7). Note that the carrying capacity is on average 3ha/head, ranging from 2.7ha to 4.9ha/head.

As outlined in Devendra (2011), the main reasons for major oil palm plantations not considering livestock integration include:

- For high value plantation crops such as rubber and oil palm, livestock will always be of secondary importance as an enterprise;
- Although livestock palm integration is sustainable, it does require substantial input into

strategic and systemic management; this added responsibility is seen as a distraction for oil palm plantation management;
- The financial impact of extra investment required, including livestock acquisition, electric fencing and extra staff/workers;
- Concerns over palm productivity, particularly palm yield, diseases of oil palm, and smear campaigns against oil palm plantations; and
- Security issues concerning theft of cattle and FFB, and damage to the trees when outsiders are allowed to bring cattle into the plantation for grazing.

Table 7. Cattle distribution at SKFPSB, Sabah, Malaysia, 2019

Region	Cattle no.	Herd no.	Herd size	Estate no.	Grazing Area (ha)	ha/head
Tawau	4,652	12	388	6	11,577	3.2
Lahad Datu	7,627	20	381	7	15,141	2.9
Sandakan	2,236	6	373	3	4,576	2.7
West	320	2	160	1	1,278	4.9
Total	14,835	40	325	17	32,572	3.0

Source: Azid (2019)

Since the adoption of livestock integration by major plantations so far has been poor, it has been suggested that efforts in promoting livestock integration should instead focus on smallholders. ICOP as an additional source of income might be more attractive to resource-poor smallholder farmers than to large companies (Devendra, 2011).

Constraints to ICOP adoption at the policy level in Malaysia and strategies to improve it, as identified by Devendra (2011), are summarised as:
- Poor awareness of the potential of the integrated system;
- Inadequate technology application;
- High prices for crude palm oil;
- Unattractive investment climate;
- Weak inter-agency collaboration; and
- Absence of policies to encourage integrated systems.

Strategies to overcome those constraints are:
- Need for a coherent and clear policy on integration;
- Awareness campaigns, dialogue and consultations with the private sector and major stakeholders about addressing issues and opportunities;
- Improvement in inter-agency coordination and collaboration to ensure efficient use of resources;
- Development of a national breeding policy and identification of suitable areas for cattle oil palm integration; and
- Stimulus packages to promote the systems, such as the provision of animals, tax breaks for allocation of land for integration, tax exemptions, interest free loans, etc.

ICOP in NBPOL, Papua New Guinea

NBPOL (New Britain Palm Oil Ltd) is the largest cattle producer in Papua New Guinea (PNG) and one of the largest palm oil producers in the world. Its 136,268ha of agriculture landholdings in PNG include 80,000ha of oil palm estates, 42,000ha of oil palm smallholders, 7,700ha of sugar cane, and 9,300ha of cattle grazing under palm (Nilkare and Worrall, 2017). NBPOL is certified by RSPO. Both Numundo Beef and Ramu Beef, owned by NBPOL, are fully vertically-integrated beef operations, from cattle breeding to beef retailing. Both are equipped with on-site feedlots, abattoirs and retail outlets. With a cattle herd of 20,000 head, they supply approximately 50 per cent of beef demand in PNG (Nilkare and Worrall, 2017).

The breeding herd at the the Numundo Beef Cattle Range is rotationally grazed in a half stand palm plantation, known as the "Numundo Half Stand System" (NHSS) (Figure 3). It is similar to the "Double Row Avenue Planting System" (DRAS) described earlier by Tohiran et al. (2014). In NHSS, two rows of oil palm are inter-spaced with 20 metres of pasture.

Incomes from the full stand (without cattle) and the NHSS (with cattle) are compared in Table 8. As can be seen for 2019, although the palm yield is lower for NHSS (17.43t/ha vs 25.5t/ha for full stand), total incomes/ha are higher (at PGK13,642 or US$4,547) than the full stand system without cattle (at PGK9,838) because of the additional income from cattle (at PKG6,917).

It is clear that NBPOL's approach to ICOP is not about simply introducing cattle into oil palm, but planned and managed strategically, as recommended in Ayob and Kabul (2009). The fully integrated system began with planting, e.g., the development of NHSS and the establishment of sole pastures to accommodate cattle production. Moreover, cattle are introduced to the palm system gradually, giving both cattle and people time to learn and adjust to the new system.

Figure 3. **The Numundo Half Stand System of NBPOL**

Source: McInnerny (2019)

Table 8. Comparison of yield and income from full stand and NHSS

Production system	Parameter	Unit	2017	2018	2019
Full Stand (without cattle)	Price/t	PGK	2,475	2,110	1,754
	Yield/palm	kg	209.38	190.54	199.21
	Yield/ha	tonne	26.6	24.2	25.5
	Income/ha	PGK	14,484	11,236	9,838
Half Stand (NHSS) (with cattle)	Price/t	PGK	2,475	2,110	1,754
	Yield/palm	kg	248.63	234.01	242.08
	Yield/ha	tonne	17.9	16.85	17.43
	Income/ha	PGK	9,747	7,832	6,725
	Income from beef/ha	PGK	NA	NA	6,917
	Total incomes/ha	PGK	NA	NA	13,642

Source: McInnerny (2019)

The trial of ICOP in NHSS commenced in 1998 on 36ha. Over time, it has been slowly expanded, reaching 9,300ha with 20,000 cattle by 2017. Despite the apparent success, revenues from the cattle business made up only 2 per cent of NBPOL's total revenues in 2014 (Nugi and Danbaro, 2018).

ICOP in Indonesia

Since 2003, the Indonesian government through the Ministry of Agriculture has been promoting the integration of beef cattle and oil palm, the so-called Sistem Integrasi Sapi Kelapa Sawit (SISKA) (System of Integrated Cattle in the Oil Palm Plantation) program (Soedjana, 2017 and Silalahi et al., 2018). Recently, the Government of Indonesia developed a roadmap for commodity development strategies (2016-2045), one of which is to achieve beef self-sufficiency by 2026 through SISKA. Regulations and policies have been introduced to accelerate the development of SISKA. These include: (i) Plantation Act No.39/2014 Articles 44(1) and 44(3); (ii) Agriculture Ministry Regulation No.98/2013 Articles 32-35; (iii) Agriculture Ministry Regulation No.105/2015; and (iv) Agriculture Ministry Decree No.43/2015 (Sudaryanto, 2017). According to (IACCB, 2020, p.13), 4.4 million ha of oil palm plantation in Indonesia have been identified as having the potential to accommodate 800,000[5] cattle. The Minister for Agriculture also proposed to increase the application of the SISKA-model from the current 0.90 per cent of total oil palm plantations (around 14 million ha in 2020) in Indonesia to 20 per cent (IACCB, 2020, p.16). Companies and smallholders in Indonesia that have been involved in SISKA since 2003 are summarised in Table 9.

The adoption patterns of palm-cattle integration in Indonesia differ (Ackerman et al., 2018), including:

- complete prohibition or limited cattle access to plantations;
- partnerships with individuals or farmer groups, that include grazing access for communities or plantation staff;
- partnerships between large plantations and large feedlotting companies; and

[5] This figure was based on a carrying capacity of 5 ha/head. In 2014, Indonesia imported 730,257 head of live cattle from Australia – the highest ever, and in 2019, 675,874 head. On average, it was 500,000/year for the past decade (Burton, 2017).

- complete ownership and management of the cattle by the plantation company.

Table 9. SISKA/ICOP operations in Indonesia

2003	PT Agricinal, Bengkulu	Semi-extensive, cattle owned by the smallholders to transport palm fruits, as source of organic fertiliser, local/Bali cattle, cow-calf operation, ± 3500 head; SISKA was first launched by Agricinal in 1997, which became the National Program of the Indonesian government in 2003
2005	PT Asian Agri, Jambi	Intensive, cow-calf operation, cattle owned by the smallholders, as source of organic fertilizer, ± 1000 head
2007	35 farmer groups in 16 provinces in Sumatra and Kalimantan	Intensive, 2,000 head of Bali cattle, biogas
2011	PT Medco Agro, Central Kalimantan	Extensive, in cooperation with feedlot, 300 head of Brahman Cross, cow-calf operation
2012	SOE (PTPN III, IV, V, VI, VII, XIII),	Intensive, cow-calf operation, fattening, Bali cattle, 5,000 head
2014	PT Citra Borneo Indah (Sulung Range), Central Kalimantan	Extensive, local and imported cattle, fattening, cow-calf operation, and 5,000+ head rotational grazing on 11,400 ha in 2016
2014	PT Santori, South Kalimantan	Extensive, Brahman Cross, cow-calf operation, 300 head
2014	PT Bionus, Bengkulu	Intensive, fattening, Brahman Cross, 125 head
2015/2019	East Kalimantan	Provincial Government (2015): Brahman Cross cows, smallholders, cow-calf operation, 11,000 head; DGLAHS support program, local/Bali cattle, 3,000 head; and PT Agro Menara Rachmat/PT Waru KalTim Plantation (2019): Brahman Cross, fattening, 4,000 head
2019	PT Astra Agro Lestari, Central Kalimantan	Extensive, Brahman Cross, fattening, cow-calf operation, 7,500+ breeding cows;

Source: Soedjana (2017); AGRINA (2019); Cendana News (2019)

Chilver et al. (2015) also produced a list of companies in Indonesia that have taken up SISKA or ICOP. A total of 20,000 head of cattle were estimated to have been raised under ICOP in 2015. However, there were no data on cattle managed in plantations by smallholders which, according to figures provided by Soedjana (2017), could be around 25,000 head. Based on our estimation, the total number of cattle under palm in Indonesia could be approximately 50,000-60,000 head in 2019. This is consistent with the figure (60,000) presented at the 2019 ICOP conference by the Agency for the Assessment and Application of Technology (BPPT).

IACCB

Four SISKA projects for cattle breeding are being trialled under the Indonesia-Australia Commercial Cattle Breeding (IACCB) Program. IACCB, which commenced in February 2016, is a project within the Indonesia-Australia Partnership on Food Security in Red Meat and Cattle Sector. The goal of IACCB is to expand the commercial-scale beef cattle breeding industry in Indonesia. It does this by working with project partners to test three cattle breeding models: (1) Integrated Oil Palm and Cattle Production; (2) Semi-intensive Grazing and (3) Smallholder Cut and Carry (IACCB, 2019). Under IACCB, cows and bulls from Australia are distributed to participating companies, as well as technical assistance and infrastructure, for start-up. In total, 1,428 cattle (1,315 heifers and 113 bulls) were distributed to eight project participants and, by January 2019, 1,396 calves had been born (IACCB, 2019, p.9).

The four SISKA projects supported by IACCB are:

- Buana Karya Bhakti (BKB) in Satui, Tanah Bumbu District, South Kalimantan province;
- Kalteng Andinipalma Lestari (KAL) in Central Seruyan Subdistrict, Seruyan District, Central Kalimantan province;
- Bio Nusantara Teknologi (BNT) in Pondok Kelapa Subdistrict, North Bengkuku District, Bengkuku province; and
- Superindo Utama Jaya (SUJ) in North Metro Subdistrict, Metro City, Lampung province.

Preliminary results from IACCB (2020) show that SISKA systems can be commercially viable[6] if they are well and professionally managed, and if there is an optimal integration so that synergy between the plantation and the cattle enterprise can be achieved. It also shows that the feeder cattle produced from a SISKA system can be competitive with feeder cattle imported from Australia, and Australian Brahman cattle can breed in Indonesia. Several issues and constraints to industry growth were also identified (IACCB, 2019, p.22). They include:

- A large increase in imports of Indian buffalo meat in Java, which has reduced the sale price of cattle, may negatively impact on the commercial viability of the IACCB breeding models;
- A lack of experienced cattle breeding managers and supervisors due to its infancy; and
- Lack of access to quality inputs and services, e.g., an absence of suitable vaccines, quality shipping services for inter-island cattle trade, commercial pasture grass seed suppliers and competent laboratories to analyse feed concentrates.

Issues in ICOP in Indonesia

As in Malaysia, despite some anecdotal evidence supporting integration, plantation companies and farmers in Indonesia are yet to be convinced of the many potential benefits associated with an integrated system. According to Sudaryanto (2017), the main challenges facing an integrated farming system in Indonesia are:

- Difficulties in sourcing sufficient numbers of local cattle in the country for large scale cattle development;
- Oil palm enterprises consider raising cattle under plantation a burden, from both technical and financial perspectives;
- Cattle grazing can cause soil compaction and certain diseases in oil palm, such as Ganoderma;
- Lack of infrastructure in the remote areas where oil palm plantations are located; and
- Inadequate coordination and synergy across institutions and government levels.

[6] IACCB studies also showed that initial investment for a productive herd of 300 Brahman cross cattle in a SIAKA model was around AUD$650,000, and operational expenses for the first three years were around AUS$350,000-400,000, depending on the level of supplementary feeding. For a herd with organic growth (with 95 per cent of heifers retained), an internal rate of return (IRR) of 10.7 per cent and a payback period of 10 years can be achieved, assuming a calving rate of 70 per cent and an average daily gain of 0.4kg (IACCB, 2020, p.11).

Policies that may influence the interest of the private sector in taking up an integrated system are: import tax of heifers, ease in getting business licence, subsidies on interest rates, and infrastructure investment in remote areas where oil palm plantation are mostly located (Sudaryanto, 2017).

Additional issues were identified by Silalahi et al. (2018) based on a review of 12 SISKA projects undertaken by both small-scale and large-scale operators. Key issues faced by small-scale operators are: the difficulty in obtaining PKC, unsuitable feed processing technology, and the issue of cattle damaging the oil palms. The key issues faced by large-scale operators are: marketing problems, the issue of cattle damaging the oil palms, and a lack of understanding of the principles and practicality of SISKA.

ICOP in Riau Province, Indonesia

Beef demand and supply in Riau

Beef consumption in Riau is around 1.0 kg/person/year. At this low level, it is likely that the majority of the population in Riau consume beef only rarely (on special occasions such as Idul Fitri, weddings, graduation, etc), and for some maybe only once a year at Idul Adha when beef is shared with the poor. In 2015, per capita poultry consumption per year was 9.6kg, which accounted for 43.64 per cent of the total animal protein consumption (Table 10). Corresponding figures for ruminant meats were 1.1kg and 5 per cent, respectively. Although not shown in Table 10, the most consumed meat in Riau was actually fish, as revealed by informants interviewed.

The consumption pattern shown in Table 10 is a result of relative prices as beef is the most expensive, followed by poultry, then fish. Most beef in Indonesia is used by the foodservice sector, especially for making bakso (meatballs). Riau is no exception. This means that few households cook beef in the home. Even at a very low consumption (about 1kg/person/year), 70 per cent of beef consumed in Riau is imported due to a small local cattle population (23,810 head). Imports include: live cattle from NTB, NTT, South Sulawesi and Lampung, frozen beef from Australia and carabeef (buffalo meat) from India.

Table 10. **Animal protein consumption pattern in Riau (kg/person/year), 2009-2015**

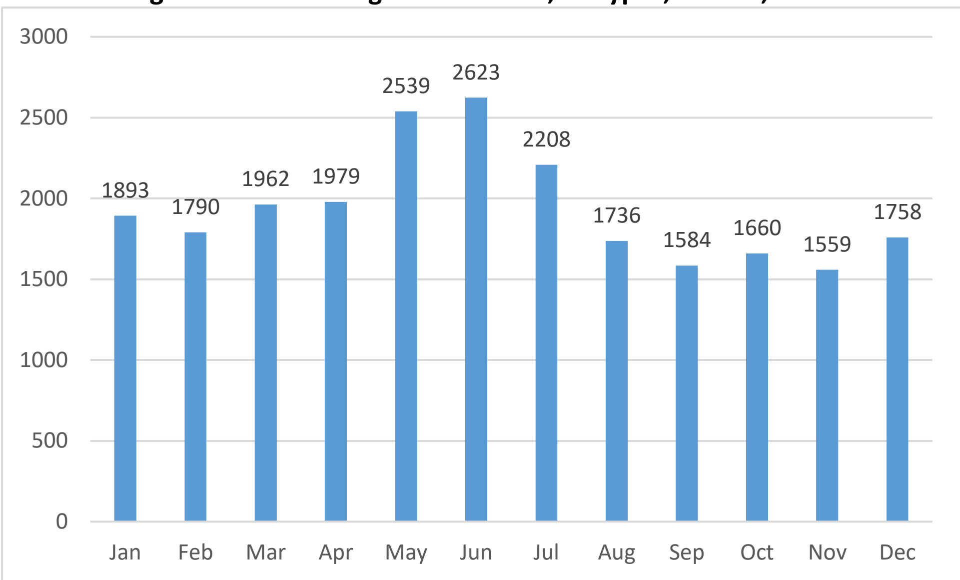
Source	2009	2010	2011	2012	2013	2014	2015	Consumption share in 2015 (%)
Ruminant meats	1.3	1.3	1.6	1.7	1.5	1.4	1.1	5.00
Poultry	5.5	5.9	7.3	7.5	7.9	8.6	9.6	43.64
Eggs	9.2	11.8	12	11.3	10.3	10.8	8.2	37.27
Milk	2.7	3.03	3.4	2.4	3	3	3.1	14.09
Total	18.7	22.03	24.3	22.9	22.7	23.8	22	100

Source: BPS Indonesia (2016)

The majority of cattle slaughtered in Pekanbaru are Australian cattle, mostly Brahman crosses, from feedlots in Lampung, Medan, and Sumatra (80 per cent). The remaining 20 per cent are local cattle from Kampar, Pelalawan, and West Sumatra. The average number of cattle slaughtered in Pekanbaru was 20-35 head/night at the time of our field work, which was a significant reduction from 30-40 head/night in previous years. The decline also occurred at Idul Fitri, from 150 head/day in 2016 to 98 head/day in 2017. The declines were attributed to the increasing availability of imported frozen beef, and the arrival of Indian buffalo meat (IBM) in late 2016. IBM was retailed at Rp.80K/kg, which was significantly cheaper than Rp.98K/kg for frozen beef and Rp.120K-130K/kg for local fresh beef.

From the field work, we learned that despite low levels of per capita beef consumption in Riau, demand for beef normally doubles or triples during major religious holidays, such as Idul Fitri and Idul Adha. Seasonal beef demand in Indonesia is well documented (Chang et al., 2020; EY Sweeney, 2018; Waldron et al., 2013; Hadi et al., 2002). Figure 4 shows the total number of cattle slaughtered in 2018, which include local cattle, Australian cattle and buffalo. As can be seen, there is only a small increase in demand for beef in June during Idul Fitri, not a surge as was seen in other provinces, such as East Kalimantan.

Figure 4. **Cattle slaughter numbers, all types, in Riau, 2018**



Source: Dinas of Livestock and Animal Health (2019)

The case for Idul Adha is also different from East Kalimantan. Cattle numbers slaughtered for regular demand and Idul Adha are shown in Table 11.

Table 11. **Cattle numbers slaughtered for regular demand and Idul Adha, Riau, 2018**

	Regular (in head)	Idul Adha (in head)	Total (in head)	% killed in Idul Ahda
SPJ	3,896	21,354	25,250	85
SPBP	352	0	352	0
SPBT	3,818	0	3,818	0
SPA	12,790	0	12,790	0
KRJ	1,645	3,644	5,289	69
KRBP	84	0	84	0
KRBT	706	0	706	0
TOTAL	23,291	24,998	48,289	52

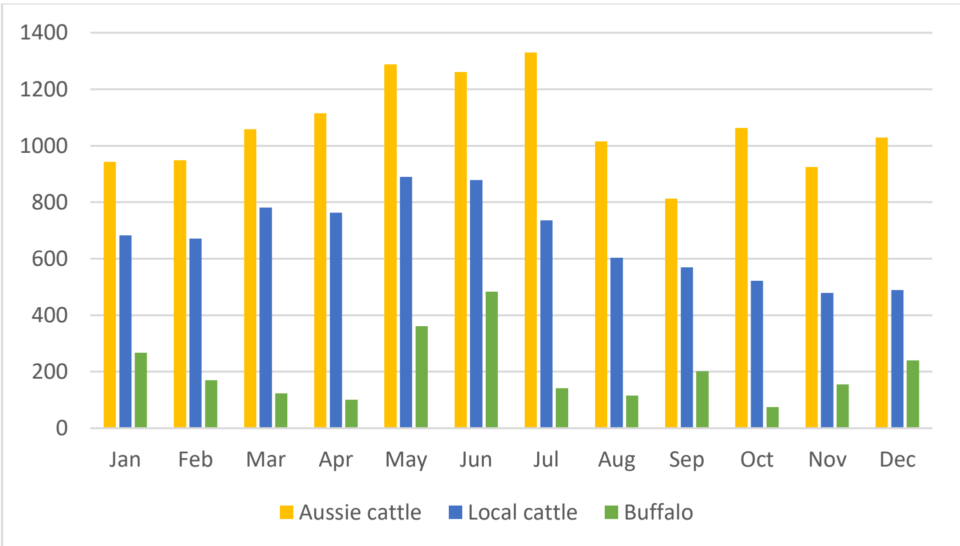
Source: Dinas of Livestock and Animal Health (2019)

As can be seen, in 2018 the number of local male cattle (SPJ) slaughtered for Idul Adha (in three days) was 21,352, which accounted for 85 per cent of total male local cattle slaughtered in the whole year. For male buffalo (KRJ), the corresponding figure was 69 per cent. Note that no Australian cattle (SPA) or female local cattle (SPBP or SPBT) or female buffalo (KRBP or KRBT) were slaughtered for Idul Adha as the market for Idul Adha prefers local male cattle that are around 200-250kg, and no body imperfection, such as ear tags/clips. Overall, the total number of cattle slaughtered for Idul Adha in three days (24,998) accounts for 52 per cent of the number of cattle slaughtered for the whole year (48,289).

Based on these observations, it does appear that the consumption patterns for beef in Riau are different from other provinces. For example, in 2018 in East Kalimantan, there was an 85 per cent increase in the demand for beef during Idul Fitri over the regular months, while the slaughter number for Idul Adha accounted for less than 25 per cent of total number slaughtered in that year (Chang et al., 2020).

Riau appears to have a more diversified and stable supply of cattle, which includes Australian cattle from feedlots in Lampung, local cattle from NTT, NTB and Sulawesi, and buffalos. Similarly, Riau has good access to frozen beef. From the field work we learned that Riau has had access to frozen beef and Indian buffalo meat for decades because of its geographical location and proximity to many ports (some imports are from Malaysia). Supply of cattle from different sources is shown in Figure 5.

Figure 5. Cattle slaughter numbers, by type, in Riau, 2018



Source: Dinas of Livestock and Animal Health (2019)

In terms of market shares, Australian cattle makes up 54.91 per cent of total fresh beef supply in Riau in 2018, while local cattle and buffalo make up 34.63 per cent and 10.45 per cent, respectively (Table 12). Of 12,790 head of Australian cattle (SPA) slaughtered in Riau, 10,529 head (82.32 per cent) were killed in Pekanbaru to serve the market in the capital city of Riau.

The low level of demand and the supply situation just described suggest that the market in Riau can be quite competitive, and cattle from ICOP must be able to compete. The strong demand for live cattle in Idul Adha also suggests marketing planning is important to take advantage of high demand at that time and to avoid oversupply at other times.

Table 12. Numbers and shares of fresh beef supply, by type of cattle, Riau, 2018

	Local cattle			Australian cattle	Buffalo			
	SPJ	SPBP	SPBT	SPA	KRJ	KRBP	KRBT	TOTAL
In head	3,896	352	3,818	12,790	1,645	84	706	23,291
In %	16.73	1.51	16.39	54.91	7.06	0.36	3.03	100.00

Source: Dinas of Livestock and Animal Health (2019)

Constraints to ICOP in Riau

Issues identified from our field work interviewing smallholder farmers practicing ICOP in Riau are:

- Reproductive issues with Brahman crosses: Brahman cross cows have difficulties in conceiving and have long calving intervals (18-24 months), compared with Bali cattle (11 months) and, therefore, they are considered not suitable for smallholders;
- Feed availability: although understory biomass and palm fronds and leaves are potential sources of cattle feed, it does take 2-3 hectares of palm plantation to accommodate one head. The average size of oil palm plantation for smallholder farmers is 2 hectares. It seems ICOP does not necessarily resolve the feed issues;
- Access to PKC is difficult either because it is not available or only available when purchased in large volumes;
- Labour shortages: the majority of oil palm farmers are also engaged in other activities (e.g., growing food crops or working as a labourer in the plantation). It may not be possible for them to take on more activities;
- Relative low returns from cattle farming: Returns to labour are higher from palm as it is less labour intensive; gross income from cattle fattening is around Rp.700K–1 million/head/month versus around Rp.3 million/ha/month from palm (which is also more regular). Similarly, plantation companies will be looking at relative returns on investment;
- Difficulty in finding markets for organic fertiliser produced from cattle manure and urine;
- Bali cattle is susceptible to Jembrana disease;[7] and
- Lack of access to credit for replanting to replace oil palm trees that are over 20 years old.

Summary of Results

Indonesia and Malaysia are the two top oil palm producers in the world and both face severe beef supply shortages. It is reasonable to assume beef self-sufficiency can be improved through ICOP. However, ICOP is not as simple as it has been portrayed. Rather, it is a highly complex process especially when it is to be implemented on a large scale. A range of issues and concerns have been identified by both companies and smallholders. Those issues and concerns, which differ between small and large producers, are constraints to the adoption and scale out of ICOP, and must be addressed through policies that provide incentives for participation, as well as technical assistance

[7] Jembrana disease is an acute viral disease of cattle. The Jembrana virus is particularly severe in Bali cattle where it has a fatality rate of approximately 17 per cent. Its first documented outbreak occurred in 1964 in the Jembrana district of Bali, Indonesia. Within two years of the outbreak the disease had killed an estimated 26,000 of the approximately 300,000 cattle on Bali Island. It occurred in Riau in 2016, and thousands of Bali cattle were lost.

and research that provide practical solutions. Progress on ICOP so far is summarised in Table 13, based on available data.

Table 13. Areas and cattle numbers under ICOP in Indonesia, Malaysia and PNG

	Grazing area (ha)	Cattle no.	Stocking rate (ha/cattle)	No. of enterprises
		Peninsular Malaysia (2006/2007)		
Estate	22,224	8,288	2.68	13
Smallholder	422,581	159,473	2.65	1,273
		Sabah (2019)		
Estate	32,572	15,000	3.00	17
		Indonesia		
Estate (2016)		14,725	NA	7 + 7 PTPN
Smallholder (2016)		27,000	NA	NA
IACCB (2018)		2,362		4
		PNG (2017)		
Estate	92,000	20,000	3.15	NBPOL

Source: Soedjana (2017); AGRINA (2019); Cendana News (2019); Nilkare and Worrall (2017); IACCB (2019)

Conclusion

The basic concept of cattle-palm integration is based on energy and nutrient recycling when the palm plantation provides feed for cattle while the cattle provide weeding services and organic fertiliser to palm. Together, more benefits are generated than if cattle and palm are produced separately. The concept of integration makes good intuitive sense, and is not new. It is similar to mixed farming that has been practiced by subsistence farmers for generations. What is different may be the degree of complexity, scale of production, and market orientation.

The review of literature from Malaysia, Papua New Guinea, and Indonesia suggests that cattle-palm integration may be more applicable to smallholders. This is because oil palm companies with thousands of hectares will benefit more from economies of scale and specialisation while smallholders are more likely to benefit from diversification and integration. Furthermore, for large oil palm companies, revenues from cattle will inherently be peripheral relative to that from oil palm. However, for smallholder oil palm producers, with 2-3 hectares per household, cattle can indeed provide additional income and serve as an economic buffer when commodity prices are low and during the replanting time.

Research conducted so far seems to suggest that environmental benefits from cattle palm integration are more clear-cut than financial benefits/returns, which depend more on management, markets, and the policy settings. Therefore, there appears to be a societal opportunity for cattle-palm integration to become a green(er) business model that places equal emphasis on profitability, social responsibility, and environmental sustainability. Such a model can help the oil palm industry address community concerns over the environment, and lend support to RSPO and ISPO initiatives promoted by both the government and the industry. Policy intervention to modify current incentives would appear to be necessary.

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