*Livestock Intensification Scenarios in Indonesia*

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# ***Abstract***

*Agricultural intensification is an advantageous solution for accommodating the projected increases in human population and demand for meat. Indonesia is a prominent example of the need for intensification as Indonesia is expected to undergo large increases in meat demand in the coming decades. However, despite past government policy efforts, new scenarios and programs are needed to ensure environmental sustainability and food security. Three scenarios were evaluated for the livestock sector: importing beef directly, importing feed, and increasing maize crop yield in Indonesia to support larger cattle populations. Importing beef and feedstock poses considerable costs to Indonesia, although the water footprint is less impacted. Using estimation methods and CROPWAT software, it was shown that increasing maize crops in West Papua would ensure a sustainable blue water footprint and satisfy beef demands. By analyzing these scenarios separately, Indonesia can make better-informed decisions on how to combine all three scenarios to achieve food security with minimal water stress.*

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# ***Introduction***

*With the world population expected to increase to 9 billion by 2050, humans will require a tremendous increase in food production to meet demand and ensure food security over the coming decades. While current agricultural production systems are able to handle this increase, these methods are often not the most efficient or sustainable way to meet food needs (PNAS, 2013). Livestock intensification represents one solution to fill the gap. The United Nations Food and Agricultural Organization (FAO) defines livestock intensification as an increase in production per unit of inputs (FAO, 2004). Thus, more animal products may be produced with fewer resources on fewer acres of land. Many developing countries undergoing increased demands for animal products are already transitioning from smallholder farming into industrial systems which are able to optimize production and reliably meet demands (van der Zijpp, Wilke & Carasan, 2010). However, for countries who already rely on smallholder farming, optimizing yields and incorporating better livestock production solutions in rural communities represents an important development to improve existing systems.*

*Around the world, the livestock sector is undergoing a turnover as population growth, urbanization, increased economic prosperity and changing dietary patterns require governments to rethink traditional systems. Most change will occur in developing nations such as sub-Saharan Africa and South Asia where demand for livestock products is projected to double by 2050 from 200 kcal/cap/day of consumed animal products in 2000 to 400 kcal/day even as population growth rates decline and increase (Thornton, 2010). Meeting this demand will require countries to transition to feed-fed animal intensification and either import or grow their own feed (Davis & D’Odorico, 2015). While traditional systems have relied on grazing and pastoralist practices, feed efficiency may represent the most important variable for increasing production while offsetting environmental concerns. Feed production is expected to intensify in areas where it is already being grown including central China, the midwestern United States, and the Latin American area including Eastern Paraguay, Southern Brazil, and Northern Argentina (FAO, 2006). This increased production will place additional burdens on blue water resources as more irrigation is needed in these areas and others in order to increase yields (Herrero and Thornton, 2013).*

*Agriculture has already been under environmental scrutiny due to greenhouse gas emissions and excessive nutrient release into water bodies. However, removing inefficiencies from current systems, subsequently allowing them to produce more livestock, may decrease environmental damage in the long term. Intensified livestock industrial systems produce less carbon dioxide per kilogram as compared to low-production systems, but excess nutrients release increases in intensified systems as more fertilizers are needed to grow feed (van der Zijpp, Wilke & Carasan, 2010). Additionally, without proper planning and education for smallholder farms, land may be intensified ineffectively leading to less area for feed production and the need for livestock to graze on crop residues and forages on marginal lands instead of grasslands (Udo et al., 2011). Thus, there is an urgent need to regulate the agricultural intensification process and integrate smallholder farmers into the market through government regulation and planning.*

*While agricultural intensification is a global trend which may be viewed at a systems-level approach, implementation of best practices at the individual level may still improve outcomes in the short to medium terms. For the purposes of this study, we will focus on Indonesia, a country dominated by smallholder systems. Additionally, we have chosen to focus on beef and cattle demand as opposed to poultry demand because beef is better incorporated in Indonesian culture and cuisine (Hutasuhut et al., 2001).*

## ***Study Area***

*Indonesia is a country where meat demand exceeds supply, and the gap between them is increasing. Live cattle and frozen meat imports are a shortcut in the short-medium term to meet this demand (Agus et al., 2018). It is found that most of Indonesia's beef and live cattle imports originate in Australia, and Indonesia remains as the largest export destination for Australian live cattle with around 296,700 head exported in 2000 (Riley et al., 2001).*

*Indonesia, with a population of 267.7 million growing at 1.1% yearly growth rate, is made up of 17,508 islands, the largest being Sumatra which includes the largest beef-producing area, Java, where most of the commercial/intensive production occurs. However, this production accounts only for 10% of meat. Indonesia is generally viewed as a water scarce country with water stress mostly due to irrigation and growing demand due to domestic water use by the growing population (Agus et al., 2018). Indonesia is under increasing water stress due to climate change and increasing irrigation withdrawal. Although Indonesia is projected to increase the amount of rainy days due to changing climate, high-intensity rain events will increase, potentially creating stress on agricultural demand (Quincieu, 2015). Flooding can also play a major role in water stress with an average of 168,000 hectares of crop inundated by floods each year from 2003-2013. Unfortunately, water management efforts by the government are hindered by decentralization, weak coordination and policy inconsistencies across government agencies (Quincieu, 2015).*

## ***Indonesian Livestock Policy to Date***

*The growth in demand for meat in developing economies such as Indonesia underpins a “livestock revolution”, which is regarded as one of the largest structural shifts ever affecting the food markets in developing countries. The way in which this revolution is handled is seen as a crucial part for food security, the livelihoods of the rural poor, and environmental sustainability (Priyant et al., 2012).*

*In 2009, the Indonesian Government promoted a national beef self-sufficiency program in response to the growing population and rising per capita demand for beef. The rise in per capita demand for beef was due to the rapid growth of the urban middle-class economy (Priyant et al., 2012). The programs aimed to increase the numbers and productivity of the domestic cattle herd. This was intended to influence the evolution of cattle production systems in Indonesia, with significant implications for small-scale producers. To help achieve this target of beef self-sufficiency by 2014, the Provincial Government of East Java launched the “Sapi Berlian” program which aimed to produce 5 million calves within five years. This program was an acceleration of a previous program that aimed to artificial inseminate (AI) one million cows and a was based on a projected growth of 2.7% in beef production, requiring extraordinary actions to be realized (Kadir, 2009). While the feasibility of this program remains unclear, the government’s action demonstrates a strong political interest to regulate and improve the livestock sector.*

*In Indonesia, the livestock subsector has received a relatively higher budgetary allocation as compared to food crops and estate sub sectors. Indonesia’s main challenge is to create an appropriate development environment, using the budget effectively and increasing the contributions of the livestock sub sector to GDP to achieve better results (Kasryno et al., 1989).*

# ***Methods***

*This study will model three scenarios in the Indonesian livestock sector and compare their advantages and disadvantages. The scenarios are intended to be viewed as comparisons of different strategies towards meeting increasing livestock demand while considering economic, environmental, and social feasibility. They are not intended to be all-encompassing practices as Indonesia will likely need to rely on multiple methods to meet livestock demand for at least the short term. However, through our comparison it is possible to understand the virtual water imports and water usage as well as additional costs of employing these methods towards meeting demand. The three scenarios include importing processed beef directly, importing feed for Indonesian cattle consumption, and increasing growing yields of feedstock (maize).*

*In order to have a clear basis to compare the scenarios, forecast calculations have been performed to estimate the cattle number that will sufficiently meet the Indonesian demand of meat in 2035. According to UNFPA report on Indonesia, the population will increase to 305 million by 2035 (2010). That combined with the average meat consumption of 11.7 Kg/year/capita in 2017 (worldindata.org), the total amount of meat required is computed. Estimates suggest that 63% of the cow becomes edible meat (“Understanding beef carcass”, 2016). In addition, the mass of the cattle at slaughter is 270 Kg and the per cattle consumption of maize over the lifetime is 1723 Kg of maize (“Beef cattle”, 2021). Combining these values, will provide an estimate of the amount of maize required to meet Indonesian meat demand for 2035.*

## ***Scenario 1: Import Processed Beef Directly***

*The increasing population and improvement of living standard will increase consumption patterns, including beef consumption. The increase of beef consumption is not compensated with the increase of beef production, thus there is a need to import beef.*

*Figure 1: Projection of National Supply and Consumption of Beef (Rudatin, 2016)*

*Figure 1 shows the projection of national supply and consumption of beef. It can be seen that throughout the years the production of beef is relatively stable, while the consumption of beef increases as the population grows. Furthermore, it is estimated that if there is no significant technology advancement in producing the local beef and no significant increase in cow population, the gap between local beef production and demand for beef will widen. Thus, it will affect the import volume and imports will increase to meet this demand (Rudatin, 2016).*

*The beef demand and the amount of beef produced in Indonesia for the year 2035 is calculated. The amount of beef to be imported is calculated by taking the difference between the demand and the beef produced in Indonesia itself. The price approximated for one kilogram of beef imported in the year 2035 is the sum of 4.9 US$ as in 2014 and adding a yearly increase of 0.4 US$ (as per the current growing trend, it will be higher if not the same). Then the total cost of import for the deficit beef demand is calculated giving the amount that will be spent on importing processed beef directly. Australia is the major exporter of beef to Indonesia and hence, for calculation purposes, we consider the data of Australia itself. The blue water footprint of the imported beef is taken from the report published by UNESCO-IHE. The land area usage for the production of the beef (including grazing, pasture land and feed crop land) is calculated using the data provided by the Australian Bureau of Statistics.*

## ***Scenario 2: Import Feed for Indonesian Cattle Consumption***

*Indonesia may also choose to import feedstocks to meet cattle consumption. Importing feedstocks increases dependence on foreign countries, but can also provide more flexibility as cattle herds increase in population. Presently, both commercialized and smallholder farmers take advantage of imported feedstock to meet cattle demands, with smallholder farmers utilizing feed during dry seasons and when natural feedstock options are all expended. However, importing feed can also have environmental impacts on the receiving nation. The increased import of soybean and maize feeds has been linked to increased nitrogen and phosphorus concentrations in the importing countries as crop and livestock production move farther apart (Wang et al., 2018). Additionally, climate change may alter the availability of forages for livestock by altering the growing periods and quantities that are naturally produced (Rojas-Downing et al., 2017).*

*Indonesia is already importing large quantities of feed in order to supplement what is grown domestically. Through the extrapolation procedure shown above for scenario 1, it is possible to calculate the total import cost for the amount of feed needed to feed the cattle population using FAOSTAT data.*

## ***Scenario 3: Increase Growing Yields of Feedstock in Indonesia***

*Based on the amount of maize required and given the yield of maize in Indonesia according to FAO website, the area required for planting this amount of maize is calculated and several two option were considered: planting maize once per year in wet season in east Java (Pasuruan) where no irrigation is required and integrating it with forage legumes to increase the yield and subsequently reduce the required area, or planting maize twice a year in an area that is 50% smaller and lessening the blue water footprint due to irrigation. However, the value of the water footprint will differ based on where the maize is planted, east Java or west Papua.*

# ***Results***

## ***Scenario 1: Import Processed Beef Directly***

*Between 1990 and 2010, the number of beef imports including both imports of beef and feeder cattle to be slaughtered in Indonesia increased by 21.58% annually (Kusriatmi, Syaukat & Said, 2014). This increase is unsustainable in the long term due to Indonesia’s growing reliance on foreign beef to provide food security for its population. However, without technological advancements and government caps on the amount of beef imported, Indonesian farmers will not be economically incentivized to increase local production. Already, Indonesian consumers may favor imported beef over locally produced beef because imported beef is produced more efficiently and can therefore often be sold for less money (Rudatin, 2016). However, prices for foreign beef can also be volatile as foreign trade deals change and Indonesia must turn to other countries to meet demand.*

*Following the trend of the current increase in beef import price, it is estimated that in 2035, the total amount of approximate 4.08 billion US$ at the cost of 12.9 US$ per kilogram will be spent on the beef imported. The blue water footprint of the cattle that is imported is found out to be 433 m3/tonne (M.M. Mekonnen et al., 2010). The land usage for cropland is calculated assuming the breed of cattle to be EU accredited breed and is found out to be 296311 hectares (Ridoutt, B. et.al, 2014). The area of land used as grazing land and pasture land is also calculated and found out to 27.5 mil ha and 1.875 mil ha respectively.*

*In order to have a clear basis to compare scenario 2 and 3, forecast calculations have been performed to estimate the cattle number that will sufficiently meet the Indonesian demand of meat. According to UNFPA report on Indonesia, the population will increase to 305 million by 2035. The results are shown in Table 1.*

| *Population in 2035* | *305000000* |  |
| --- | --- | --- |
| *Meat Consumption* | *3.28* | *kg/capita/year* |
| *Demand in 2035* | *3568500000* | *kg* |
| *Edible meat per cattle* | *63%* |  |
| *Mass of cattle needed* | *5664285714* | *kg* |
| *Average mass of cattle* | *270* | *kg/cattle* |
|  |  |  |
| *Current mass of cattle* | *4455000000* | *kg* |
| *Edible meat in cattle* | *2806650000* | *kg* |
| *Deficit (import needed)* | *761850000* | *kg* |
| *Import in tonnes* | *761850* | *tonnes* |
| *Cost of import* | *9827865000* | *$USD* |

*Table 1: Beef import costs*

## ***Scenario 2: Import Feed for Indonesian Cattle Consumption***

*The calculations for the import of feedstock are shown in Table 2. In 2019, the total import cost of feedstock including gluten feed and meal, feed supplements, feed compound, and feed made from vegetable products for Indonesia was $333,195,000 (FAOSTAT, 2021). Given a total cattle population of 17,118,650 in 2019, each cow (if fed only imported feedstock) would cost $19.46 USD/cattle/year. Given a forecasted cattle population of 20,978,836 in 2035, and holding the unit price of cattle constant for each cattle, the total import cost for feedstock would be $408,329,117.89.*

| *Year* | *2019* | *2035* |
| --- | --- | --- |
| *Cattle Population* | *17,118,650* | *20,978,836* |
| *Feed Import Cost* | *$333,195,000* | *$408,329,117.89* |
| *Feed price per unit of cattle per year* | *$19.46* | *$19.46* |

*Table 2. Projected cost of importing feed for total cattle population*

*These calculations are a rudimentary estimate based on the projected cattle populations that will be needed to meet the population demand in 2035. This calculation assumes that the feed price per unit of cattle per year will remain constant; however, in reality the unit price may fluctuate depending on the average slaughter weight as well as the number of cattle owned by each farmer. Additionally, this calculation can only account for the additional feed already needed by Indonesia. It does not include the percentage of the cattle that are fed only by natural forages for which data were unavailable.*

## ***Scenario 3: Increase Growing Yields of Feedstock in Indonesia***

*The calculations were based on irrigation requirements obtained from using both CLIMWAT and CROPWAT softwares. First, the stations used included Pasuruan in east Java where most of the current maize planted are and East Papua. Two options were considered including planting once per year and integrating maize with forage legumes in a mixed system to increase the yield and provide more feed, or planting twice per year and halving the original required area.*

*Both of these options were investigated, as shown in Table 3 based on some assumptions for the yield in 2019 according to FAOSTAT (assumed to be constant till 2035), where the required area is calculated. The first option is to grow once per year in east Java and the data used for CROPWAT was retrieved from Pasuruan station in CLIMWAT and medium soil type was used. It was found that if the maize was planted in mid-December (15/12) no irrigation is required; however, this option required the use of a large amount of area to grow maize that is only used for feed. This area was calculated to be equal to the current area used to meet demand plus the area of maize that could be grown to equal the maize that would normally be imported for feed to Indonesia.*

*The second option was to plant maize twice a year. This resulted in needing only half of the area needed if maize was planted once per year. This is a more realistic area distribution because if maize is grown twice a year in east Java, it was found that the required irrigation is significantly higher (379 mm). The chosen second date of planting is the first of March (01/06). However, considering the climatic conditions of west Papua, specifically Manokwari-Rendani station, it was found that the irrigation requirement is reasonable (32 mm) leading to a blue water footprint for maize of 29 m3/tonne. For this reason, west Papua should be used as an additional area to grow maize for feed because it is a forest region where cash crops (palm oil) are not grown intensively and there is the possibility to turn the area into an agricultural land.*

| *Scenario 3* | | | |
| --- | --- | --- | --- |
| *Yield* | | *54375* | *hg/ha* |
| *area required* | | *6647639* | *ha* |
| *Location 26: Pasuruan*    *Planting Date 15/01* | *If grown once per year* | | |
| *BWF* | *0 (Rain-fed)* | *m3/tonne* |
| *Location 26: Pasuruan*    *First planting Date 15/01 , Second planting date 01/06* | *If grown twice per year* | | |
| *Required Irrigation* | *378.8* | *mm* |
| *total amount of blue water required* | *12590627336* | *m3* |
| *BWF* | *348* | *m3/tonne* |
| *Location 5: Manokwari-Rendani*    *First planting Date 15/01 , Second planting date 01/06* | *If grown twice per year* | | |
| *Required Irrigation* | *32* | *mm* |
| *total amount of blue water required* | *1063622161* | *m3* |
| *BWF* | *29* | *m3/tonne* |

*Table 3: Blue water footprint estimation of locally grown maize feed (Scenario 3)*

## ***Limitations***

*Some assumptions were taken while forecasting the calculations. In scenario 1, in order to calculate the future required import of meat in 2035, the current Indonesian production is assumed to be the same in 2035 as in 2019 as it appeared to be constant from 2014-2024 forecast. In scenario 2, the data from FAOSTAT for the feed prices of import in 2019 were used to have a cost per cattle for feed; however, it was assumed that this amount of feed is distributed equally to all current population of cattle without accounting for forage feed or locally grown feed. In addition, it was assumed that the price of feed import is constant per head of cattle when projected to 2035. For scenario 3, the yield of maize in 2019 was taken to be constant until 2035. Additionally, maize production yields did not include the leftover forages in the field that may also be used as feed.*

# ***Conclusion***

*This study provides an overview of livestock intensification scenarios for Indonesia. In reality, Indonesia, will likely utilize all three scenarios to meet their demand for beef, but considering each scenario separately allows one to understand the advantages and disadvantages associated with each. Additionally, Indonesia must incorporate scenarios 2 and 3 into their current policies if they wish to improve food security and manage rising demand for beef and population growth. If Indonesia decides to import all of their meat to meet demand in 2035, the cost will be nearly $10 billion USD which is unsustainable in the long term. However, scenarios 2 and 3 also pose issues. Like scenario 1, scenario 2 does not place stress on Indonesian water resources because importing meat or feed is a virtual water import. However, importing feed in 2035 will still cost approximately $408 million USD at the most conservative estimate, assuming the percentage of forage already used to feed the cattle population will stay the same as the cattle population increases. Additionally, Indonesia should be concerned about excessive nutrients entering the ecosystem due to importing feed. Scenario 3 presents one pathway towards self-sufficiency by intensifying feed production within the country. Current agricultural production occurs mainly in East Java where intensifying production will exacerbate blue water supplies. Thus, Indonesia should consider alternatives, such as optimizing existing yields in East Java and allocating space in other areas such as West Papua for feed production. These methods, along with proper livestock management and education will ensure a sustainable future for the Indonesian livestock sector.*

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