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Modeling smallholder beef farming: a systems thinking's step by step approach

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Modeling smallholder beef farming: a systems thinking's step by step approach

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Abstract. Smallholders are characterized by the complexity of the connectivity of allocating limited resources to support their multi activities in agriculture. Learning smallholders requires an approach which able to acknowledge and elaborate the nature of their complexity. Systems thinking is one of the disciplines of thinking focused on analyzing the interconnectedness among elements within a system. This study aimed to highlight a step by step process in developing a model for smallholder beef farming. The study has been undertaken in rural Central Java at two beef farmers group. Numbers of semi-structured interviews followed by focus group discussions and in-depth interviews to clarify the findings have been conducted involving a total of 50 respondents of farmers. The study revealed operational process which needs to be followed to undertake five steps of standard qualitative modeling practices, i.e., observing the everyday activities of the farming, problem identification, developing a conceptual framework, canvassing the maps of qualitative modelling using Causal Loop Diagram (CLD), and identifying the systems archetypes within the CLD. Qualitative maps of CLD describing the behaviour of the systems of smallholders beef farming.

1. Introduction

Beef farming is a complex socioeconomic activity which involves numbers of stakeholders whose aim and interest are varied [1,2,3]. In many parts of Indonesia beef farming is just one activity among many different activities undertaken by farmer on their daily basis. Beef farming is nested within bigger agricultural systems. Further, beef farming plays varied roles to the community. It never plays a single role as an income source, but always have other roles as household saving, buffer, or social status. Within a beef farming systems, a lot of stakeholders involved, such as local traders, farmers, extension agents, local government, or even researchers. Each stakeholder has their objectives which shape the beef farming systems in certain area.

For decades, although smallholders dominate the supply of national beef [4] their productivity tends to be low [5]. Also, smallholders are characterized for their limited number of cattle per farmers, limited capital owned, labour intensive, limited land area [6], limited access to financial institution, mostly un-bankable, and traditional managerial practices. This lead to limited income generated from beef farming. Thus, drive farmers to do other income generating activities either agricultural-related or non-agricultural activities. The ability for farmers to wisely allocate their limited resources plays a crucial role to sustain their livelihood, thus challenging to be studied further.

The fundamental problem needs to be addressed to explore the possible intervention strategy to improve the productivity of the smallholders. However, to study such complex systems requires an approach which sensitive and acknowledge the complexity of a beef farming system. One emerging idea to study a complex system is systems thinking [7,8,9] which focused on the relationship among elements within a system. In the body of systems thinking, numbers of methods have been introduced. However, in principle, it divides into two disciplines; qualitative and quantitative approach. Each approach has strengths as well as limitations. It should be used as a complementary rather than a substitution. Further, a methodology which has been developed to undertake those approaches were widely varied such as systems dynamics [10], soft systems methodology [11], Critical Systems Heuristics [12], Soft Systems Dynamic Methodology [13]. Recently, [2] published an enhanced SD approach which nominated as the most suitable systems thinking methodology for smallholders.

The base of any systems analysis is interrelationship among elements which could be further examined using a model. However, as one element always has certain linkages to other elements, in many cases researcher could be easily lost in the complexity of the model. This article aimed to discuss the step by step process systems analysis to develop a qualitative model of the smallholder beef farming system in a quest to provide protocols for researcher or practitioners interested to build a model for smallholders.

2. Methods

The study has been undertaken in Kecamatan Bawang, Kabupaten Banjarnegara involve all members of the beef farmer group. Kecamatan Bawang was chosen purposively as the kecamatan used to be the most beef farmers operating a cow-calves system. Farmer group was also selected purposively with major criteria as long endured farmers group, has to experience in managing government program, operates an integrative beef, rice, and fish farming, and proved to be sustainable. The criteria were necessary as it reflects the ability of the groups to manage their limited resources.

A combination of semi-structured interviews, focus group discussions, and a series of workshop has been undertaken to study the behaviour of beef farming systems. This study follows the steps of developing a system model from [2]. These steps include observing the systems, problem structuring, and systems mapping. The research process was shown as a fishbone diagram at figure 1.

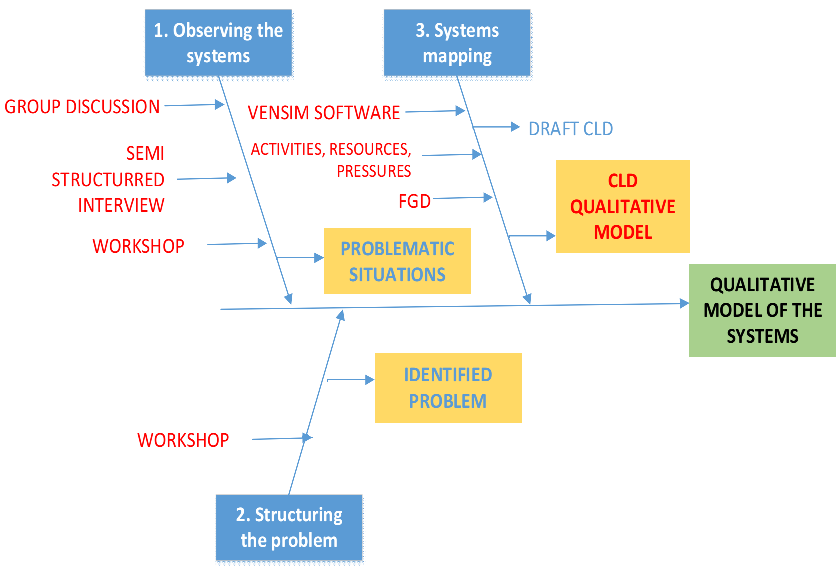

Figure 1. Fishbone Diagram of Research steps

Research steps are presented in blue box, output from each step is in yellow, whereas green box shows the final target of the research. Operational method to undertake each step is presented in red font.

3. Results and discussion

3.1. Observing the system
The goal of this step was to capture the daily activities of the farmers related to their beef farming. It was started with conducting an informal discussion with farmers' group representative to discuss about the upcoming research. This initial steps was quite crucial as a phase to develop farmers' sense of being acknowledged [14]. Then, semi-structured interview was conducted to explore perspectives and opinions of the farmers about their current farming practices as well as identifying the key persons or champions in the group. During the interview, farmers were asked to mention three most substantial problems to their farming.

3.2. Structuring the problem
Step 1 produces a long list of potential problems. Researcher was then categorized the problems and resulted in 10 categories of potential problems; i.e. lack of capital, limited income, forage shortage during dry season, shifting from cow-calf operation to fattening, limited land area, limited number of cattle per farmer, price uncertainty, very long calving interval, threat from live cattle import, and lack of government support. Further, these ten potential problems were then discussed in a workshop with all participants to determine one most important problem. As a result, all participants agree that *limited farmers' income from beef farming* is the common problem.

3.3. Systems mapping
This step aimed to develop a causal loop diagram, a qualitative model of the system. An FGD has been carried out to do the mapping. Three major elements were explored in this steps which include detecting (i) the activities which practiced by farmers in a daily basis, (ii) the resources required and affected by those activities, and (iii) the pressures affecting or affected by both activities and resources. It was recommended to have at least three persons to conduct an FGD. One facilitator to lead and encourage participants to speak, one person as software driver to draw the map, and one person in charge of note taking and recording. Software used in this steps was Vensim® software developed by Ventana System Inc.

3.3.1. Activities. In this steps, the FGD facilitator asked stakeholders to identify the activities that influence the problem. A total of six activities were identified: beef fattening, cow-calf farming (breeding), inseminating cows, feeding the cattle, cattle purchasing, and cattle selling. Then, participants were asked to describe the interaction existed among activities. For modeling purposes, each relation should be attached with polarity, a positive polarity (+) represent a same direction relationship, whereas negative (-) if the two activities showed an opposite relationship.

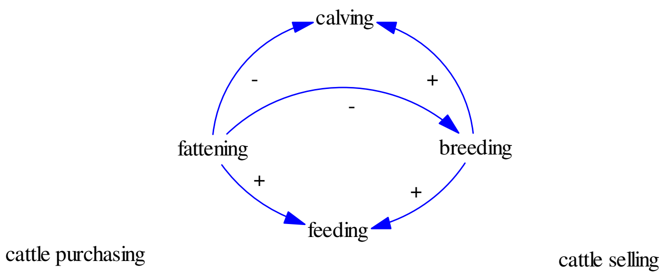

Figure 2. CLD activities

3.3.2. Resources. Facilitator selected one activity and asked FGD participants to identify resources directly affected by that activity. A total of four resources were identified; cattle for fattening, cattle for breeding cows, calves, and forages. Then, facilitators asked participants to identify the relationship between this activity and resource. After all activities and resources have been identified, then interrelation between resources to recourse should also be identified. Figure 3 showed that calving was the engine of growth of the cattle population. This was highlighted by the following reinforcing loop; more calving – produces more calves– more cattle for breeding – more breeding – more calving. However, the CLD also have three balancing loops: First, more cattle for fattening – more fattening – less calving – less calves – less cattle for fattening. Second, more cattle for fattening – more fattening – more selling – less cattle for fattening. Third; more cattle for fattening/breeding – more fattening/breeding – more feeding – less forages carrying capacity – less cattle for fattening/breeding. Further analysis of the systems resulted in the following behaviour: (i) breeding and fattening consume the same resources. This means that more fattening activity will reduce breeding. Current practice of shifting from breeding to fattening will reduce calving thus constrain the population growth; (ii) breeding is the engine of growth of the systems. More cattle allocated for breeding will increase cattle population; and (iii) both breeding and fattening consumes forages, thus more cattle will reduce the forage carrying capacity.

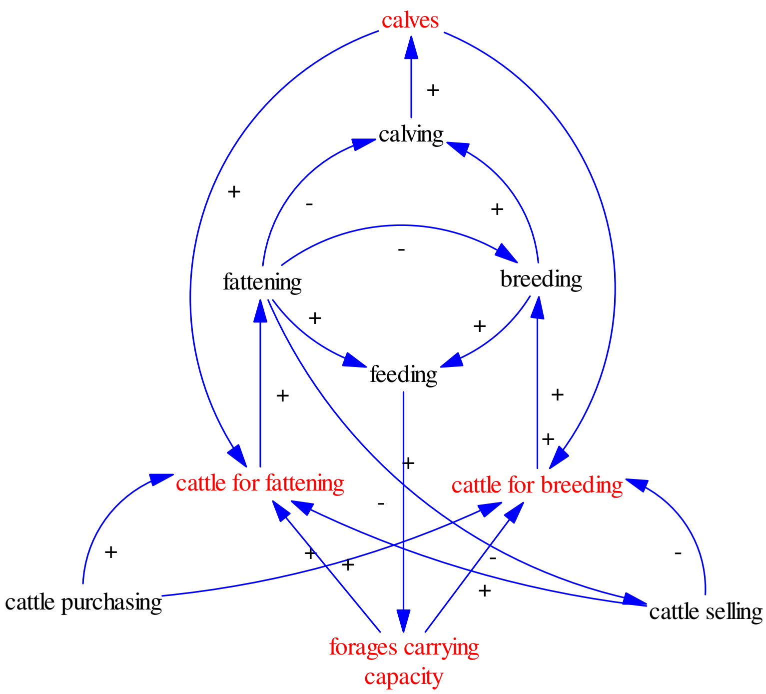

Figure 3. CLD activities and resources

3.3.3. Pressures. Facilitator selected one activity and asked stakeholders if any pressures have influenced the past trend in that activity. After all pressures affecting all activities and resources have been identified, the next step was describing the link and polarity between pressures-resources-activities. A total of eight pressures were identified; live cattle import, cattle price, the proportion of cattle for fattening, the proportion of cattle for breeding, household necessity, expected income, sales income and the gap between expected and actual income. A complete causal loop diagram was shown in figure 4 which highlight how cattle price and the gap between expected and actual income affect the systems' behaviour. Farmers argued that policy aimed to reduce beef price would significantly affect the systems. Beef import reduces the price. It has a double impact. First, the import will increase the tendency for farmers to operate fattening rather than breeding to minimize risk. Second, the import will reduce sales earning which will further suppress breeding. Less breeding will lead to less population and more dependent on import to fulfill beef demand.

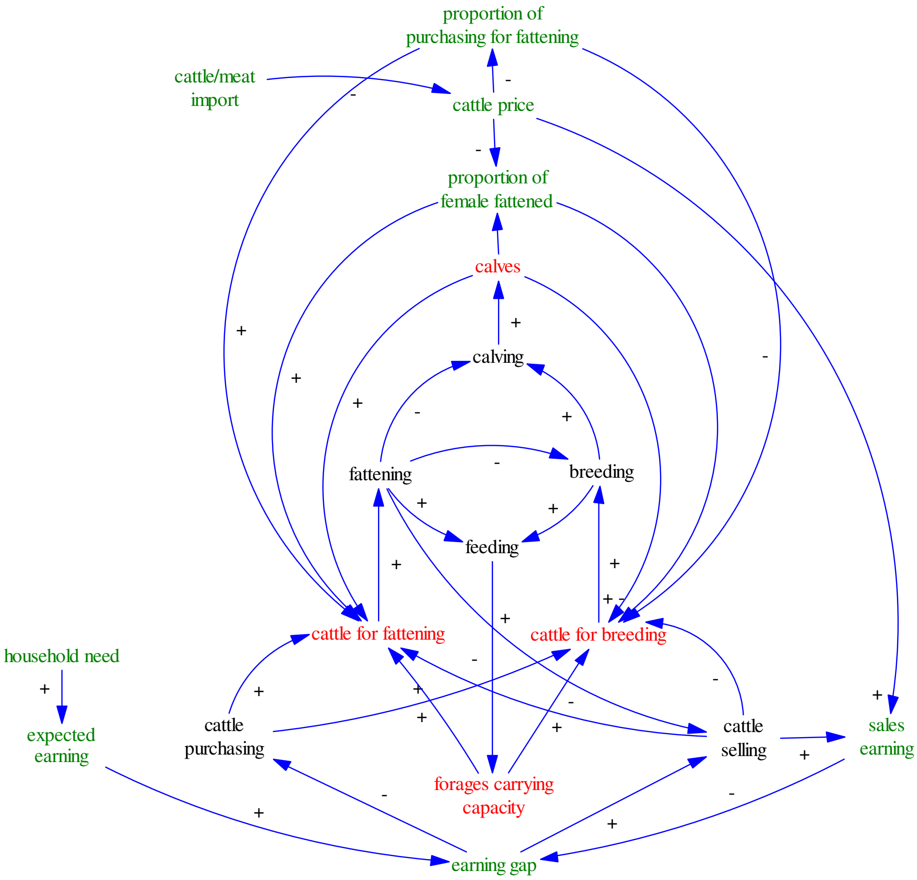

Figure 4. CLD of activities, resources, and pressures

The logic and behaviour of the systems produced by this protocols were relatively similar to those produced from an enhanced systems dynamic methodology [2]. Therefore, the protocol could be used as a step by step methods to develop a qualitative model.

4. Conclusion

Three steps of observing the systems, structuring the problem and generate systems mapping could be proposed as a protocol for developing a causal loop model. The complexity of systems mapping was able to be tamed using the systematic identification of activities, resources, and pressures which able to help participants thinking.

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