An ISM approach for identifying and analyzing the complexity of beef cattle farming problems in Central Java

I W Pratama¹, M A U Muzayyanah¹, A Astuti², I G S Budisatria³ and A R S Putra¹,*

¹Department of Livestock Social Economics, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281, Indonesia
²Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281, Indonesia
³Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281, Indonesia

Corresponding author: ahmadromadhoni@ugm.ac.id

Abstract. The complexity of the problems in the beef cattle farming system in Central Java is challenging. Identification and mapping of the problems are an important part of the process to determine the policy strategy. The research objectives were to identify and to map the problem structure in beef cattle farming system in Central Java. Interpretive Structural Modeling (ISM) was employed to analyze the relationship between problems in beef cattle farming system. Data were collected through literature review and in-depth interviews with several stakeholders which consisting of academics, practitioners, and local governments. The results showed that the problems of beef cattle farming in Central Java were related to the availability of feed, farmers socio-economic conditions, and the production and reproduction of the cattle. Problems related to the animal feed availability is a leverage point in solving cattle problems in Central Java. The feed strengthening strategy is expected being priority in the context of developing beef cattle farms in Central Java.

1. Introduction

Central Java Province is one of the centers of beef production in Indonesia, however the existing production has not been able to meet the demand from the community. The beef cattle production in Central Java is only able to fulfill about 74.21% of the total consumption needs [1,2]. In the other side, the results of Total Digestible Nutrient (TDN) analysis shows that Central Java Province able to accommodate up to 5,232,130 Livestock Units (LU) [3]. The shortage of beef production must be immediately followed up by applying a strategic policy which is needed to increase beef production.

Cattle farming in Indonesia, including Central Java Province, is generally managed by small-scale farmers (2-3 cows per farmer) with a traditional system. The purpose of raising livestock are generally for source of savings for financial security and investment [4]. Other characteristic of small-scale farmers are livestock reared behind or beside the house, raised as side business, limited forage land ownership, inherited from parents, and limited capital to apply a profit sharing system [5].
Problems regarding beef cattle farming, including in Central Java Province, are due to the lack of linkage within a sustainable agribusiness system. It consists of the upstream and downstream subsystem. The upstream belongs to procurement of production facilities, on farm, and the downstream one are the postharvest processing, and marketing and supporting subsystems [6]. Beef production in an area is simply influenced by the population and productivity of beef cattle in which have an effect of 55.1 % on beef production in the area [7,8]. On the other hand, the beef cattle population is also affected by livestock mortality, disease control, control of slaughtering productive males and females, provision of quality feed, and importation of seeds [9].

The complex problem of beef cattle production in Central Java Province can be solved by a well-targeted policy. Identification of problems should be carried out as a basis of a policy formulation. It begins from starting with the goal, then identifying the problem which is defined the gap between the goal (informative condition) and the actual situation, and followed with problem solving [10]. Therefore, this study aims to identify and to map the problem structure of beef cattle in Central Java Province.

2. Materials and methods

This research was conducted in Central Java Province, Indonesia from December 2020 to May 2021. Data collection was carried out through in-depth interviews with seven stakeholders as respondent. Secondary data were also used to provide supporting information for the research. Informants are selected by the judgmental sampling method based on stakeholder’s criteria. The criteria used in determining research respondent are having adequate experience in accordance with cattle farming and beef production (particularly in Central Java), having a reputation and demonstrating credibility as a stakeholder or expert in the beef production. The qualifications of the respondent in this study can be seen in Table 1.

| Table 1. The qualified experts’ profile |
|----------------------------------------|
| Indicator                          | Points | Exp 1 | Exp 2 | Exp 3 | Exp 4 | Exp 5 | Exp 6 | Exp 7 |
|-------------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|
| Position                            | 2      | YES   | YES   | NO    | NO    | YES   | YES   | NO    |
| Working experience                  | 1      | 12    | 12    | 11    | 25    | 24    | 22    | 24    |
| Experience as a resource person     | 2      | YES   | YES   | NO    | YES   | YES   | YES   | YES   |
| Team of Beef sufficiency program    | 2      | NO    | YES   | YES   | NO    | YES   | YES   | YES   |
| Scientific experience               | 2      | YES   | YES   | YES   | YES   | NO    | YES   | YES   |
| Writing a Book                      | 2      | NO    | NO    | NO    | YES   | NO    | YES   | NO    |
| Training experience                 | 1      | NO    | YES   | YES   | YES   | NO    | YES   | YES   |
| Formal Education                    |        | BS=1  | MS=2  | PhD=4 |       |       |       |       |
|                                     |        | MS    | MS    | PhD   | BS    | PhD   | MS    |       |
|                                     |        | 20    | 25    | 20    | 37    | 32    | 39    | 35    |

Interpretive Structural Modelling (ISM) was employed as research analysis tool. Data analysis was carried out with the help of ISM-Professional 2.0 software. ISM analysis consists of several stages, namely variable identification, contextual relationship determination, preparation of the VAXO Structural Self Interaction Matrix (SSIM), transformation of VAXO SSIM into Reachability Matrix (RM), RM transitivity testing, making canonical matrix based on Driver Power (DP) and Dependence values from the final RM results, and hierarchical arrangement based on variable ranking in the form of a directed graph (diagraph).
3. Results and discussion

The development of beef cattle farming in Central Java Province is still facing various problems. These problems are widely ranged from the availability and quality of feed, cattle productivity to the socio-economic problems of farmers. These problems correlated to the characteristics of beef cattle farming such as low number of cattle ownership, the purpose of raising cattle as a saving, keeping cattle in densely populated settlements, limited ownership of forage land, etc. [5]. Problems in cattle development based on the literature review can be seen in Table 2.

Table 2. The problem of developing beef cattle farms in Central Java

| Code | Element                  | Problems                                                                 |
|------|--------------------------|--------------------------------------------------------------------------|
| A1   | Feed availability        | Availability of seasonal agricultural waste feed [11–13]               |
| A2   | Low quality of forage   | [11–14]                                                                  |
| A3   | Low feed technology     | Applications [4,11,13]                                                  |
| A4   | Limited land            | [4]                                                                      |
| A5   | Uneven population       | Distribution [15]                                                       |
| A6   | Cattle productivity     | High calf mortality [14]                                                 |
| A7   | Long calving intervals  | [14]                                                                     |
| A8   | Limitations and a       | Decrease in the number of brood-stock [16,17]                           |
| A9   | Low conception rate     | [14]                                                                     |
| A10  | Low productivity of     | Local cattle [16]                                                       |
| A11  | Reproductive diseases   | [12]                                                                     |
| A12  | Farmers’ social         | economics Animal husbandry as a side job [11,15]                       |
| A13  | Traditional maintenance | patterns [4,11,15]                                                      |
| A14  | Low livestock ownership | [14,15,18]                                                              |
| A15  | Capital                 | [13,15]                                                                 |

Low productivity of beef cattle and the availability of feed are still the main problems in beef cattle farming. In addition, socio-economic factors causing farmers to have income from other sources, hence, raising cattle is only a side business. It is widely known that production factors including business scale, animal feed, health, reproduction and labor are still not managed efficiently [18].

The structuring of beef cattle farming problems in Central Java was carried out using the Interpretive Structural Modeling (ISM) method. The results of the analysis are displayed in the form of a Dependence Power Matrix (DP-D Matrix) and a scheme of linkages between factors. The DP-D Matrix was formed based on grouping the research factors into four quadrants, namely independent quadrant (quadrant 1), linkage (quadrant 2), dependent (quadrant 3), and autonomous (quadrant 4), while the linkage scheme between factors was formed based on calculations value of dependence and strength of each factor against other factors. The DP-D matrix and the linkage scheme between factors can be seen in Figure 1 and Figure 2, respectively.
According to the results of grouping various factors into the DP-D Matrix, in general, the existing factors spread into all quadrants. However, there is an interesting pattern regarding the distribution of these factors. The independent quadrant is filled by several problems related to the dimensions of feed, the linkage quadrant is mostly filled by problems related to the socio-economic problems of farmers, and the dependent and autonomous quadrants are mostly filled by livestock productivity problems. These results indirectly explain that the main problem of beef cattle farming in Central Java is the problem of animal feed. This is also supported by the previous research which explains that the availability of feed has a very large influence on ruminant livestock farming including beef cattle farming [19]. The pattern of relationships between several beef cattle farming problems in Central Java is also presented in the form of a relationship structure.

Figure 1. Dependence power matrix

Figure 2. Structure of beef cattle farming problems in Central Java Province
The linkage scheme among factors in beef cattle farming problems in Central Java can be used to determine policy priorities. Based on the results of the study, improvements of feed production should be the top priority in the development of beef cattle farms in Central Java. These efforts can be started from improving the quantity of animal feed production and the quality of forage. Improving the quality of forage feeds may be expected to drive improvements in other factors such as cattle productivity and the socio-economic conditions of farmers.

The implementation of an integrated farming and livestock system, maximizing the use of forage feeds and utilizing the potential of local forage may increase the availability of livestock feed [12,20,21]. This may encourage the improvement of the quality and quantity of feed for beef cattle in Central Java. The integration of farming and livestock practice by farmers may utilize the use of food crop waste as animal feed, and livestock manure as organic fertilizer for agricultural land [20]. Therefore, this should be continuously promoted to beef cattle farmers through training programs and technical assistance [22].

4. Conclusions
The beef cattle farming system in Central Java Province still facing various problems, such as feed availability, beef productivity and the socio-economic condition of farmers. The feed availability particularly forage becomes the leverage point in the beef production in the province. The low quality of seasonal forage and feed production become the greatest impact on the beef cattle productivity. Improvements to the beef cattle productivity should supported by increasing the quality and quantity of forage especially the local source.

Acknowledgments
We acknowledge to Universitas Gadjah Mada through Rekognisi Tugas Akhir scheme (Contract No. 3143/UN1.P.III/DIT-LIT/PT/2021) for providing the funding of this research. We are also grateful to the Regional Development Planning Agency of Central Java Province (Bappeda), the Livestock and Animal Health Agency of Central Java Province, the Central Java Assessment Institute for Agricultural Technology, the Ungaran Artificial Insemination Center, the Indonesian Cattle Farmer Association (Gapuspindo), and Novie Andri Setianto, S.Pt., M.Sc., Ph.D. from Faculty of Animal Science Jenderal Soedirman University for the information support for this research.

References
[1] BPS Statistics Indonesia 2018 Indonesia Population Projection 2015-2045 (Jakarta: Badan Pusat Statistik)
[2] CADIS 2019 Food Consumption Bulletin vol 10 (Jakarta: Center for Agriculture Data and Information Systems, Ministry of Agriculture of the Republic of Indonesia)
[3] Susanti Y, Priyarsono D S and Mulatsih S 2017 J. Indones. Agribus. 2 177
[4] Sodiq A, Yuwono P, Sumarsono J, Wakhidati Y N, Rayhan M, Sidhi A H and Maulianto A 2019 IOP Conf. Ser. Earth Environ. Sci. 250 012050
[5] Zakiah Z, Saleh A and Matindas K 2017 J. Penyul. 13 133
[6] Widiati R 2014 Wartazoa 24 191–200
[7] Santoso A B and Nurfaizin N 2017 Agriekonomika 6 176–87
[8] Priyono P and Hapsari A A 2017 Teknologi Peternakan dan Veteriner Mendukung Diversifikasi Sumber Protein Asal Ternak (Bogor: Pusat Penelitian dan Pengembangan Peternakan) p 248–56
[9] Rusdiana S dan Praharani L 2019 Forum Penelit. Agro Ekon. 36 97
[10] Nuralma R 2017 Berpikir sistem (system thinking) dalam pendekatan sistem (system aproach) [System thinking in a sistem approach] Memaju Agribisnis Indonesia yang Berdaya Saing (Bogor: Departemen Agribisnis Fakultas Ekonomi dan Manajemen Institute Pertanian Bogor) p 15–24
[11] Parmawati R, Mashudi, Budiarto A and Kurnianto A S 2018 Tropical Animal Science Journal 41
67–76
[12] Sodiq A, Yuwono P, Sumarmono J, Santosa S A, Wakhidati Y N, Fauziyah F R, Rayhan M, Sidhi A H and Maulianto A 2019 AIP Conference Proceedings 2094 020028
[13] Ekowati T, Darwanto D H, Nurtini S and Suryantini A 2011 *J. Indones. Trop. Anim. Agric.* 36 281–89
[14] Bunmee T, Chaiwang N, Kaewkot C and Jaturasitha S 2018 *Asian-Australasian J. Anim. Sci.* 31 968–75
[15] Mukson, Roessali W and Setiyawan H 2014 *J. Peternak. Indones.* 16 26–31
[16] Rusdiana S, Ismail I, Sulaiman R, Amiruddin A, Daud R, Zainuddin Z and Sabri M 2018 *Int. J. Trop. Vet. Biomed. Res.* 3 48–59
[17] Roessali W, Masyhuri M, Nurtini S and Darwanto D H 2011 *J. Indones. Trop. Anim. Agric.* 36 27–35
[18] Ekowati T, Prasetyo E and Handayani M 2018 *J. Indones. Trop. Anim. Agric.* 43 76
[19] Lange A, Siebert R and Barkmann T 2015 *Sustain.* 7 683–704
[20] Elly F H, Lomboan A, Kaunang C L, Rundengan M, Poli Z and Syarifuddin S 2020 *Anim. Prod.* 21 143
[21] Pratama I W, Agustine R, Astuti A, Kasmiyati, Noviandi C T, Agus A and Putra A R S 2021 IOP Conf. Ser.: Earth Environ. Sci. 782 022086
[22] Widarni N A A, Kusumastuti T A and Putra A R S 2020 *J. Indones. Trop. Anim. Agric.* 45 356–64