



Analysis of Swamp Buffalo (*Bubalus Bubalis*) Farming Business and its Productivity in Central Java Province, Indonesia

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Abstract | A study was carried out to investigate the farming model and productivity of buffalo raised by small farmers in Central Java Province, Indonesia. This study was conducted by a survey method in seven regencies which were chosen for highest population of buffalo, indicating the interest of the farmers and environmental suitability of the regions for buffalo farming. Three hundred and eighty buffalo farmers were chosen as respondents for having been at least 3 years buffalo farming experience. They were interviewed using open questionnaires for buffalo raising practices and economic feasibility. The data collected were characteristics of the respondents, reproductive performance, and economic analysis of the buffalo farming. The data of buffalo growth rate were collected by cross-sectional comparison method. The data obtained were processed by statistical procedures and interpreted descriptively and quantitatively. The results showed that the majority of buffalo farmers were working as crop farmers. They were in productive working age with elementary school educated, having more than 10 years buffalo farming experience. Fifty two percent of the farmers had less than 3 animal units (AU) buffaloes. They spent 3-6 hours a day for caring their buffaloes. The buffaloes were fed grass or agricultural waste. The buffaloes were mated by natural mating. The age at first calving of the cow buffalo in this study was 3.3 years with calving interval being 19.8 months. The buffalo calves were weaned at 8.2 months of age. The buffalo grew from birth until they reach maturity at around 12 -15 months of age. This study found that Return on Investment (ROI) was 11.6 and benefit-cost ratio (BCR) was 2.4. The profit obtained by the buffalo farmers was IDR 190,670/year/AU. In conclusion, the buffalo farming in Central Java Province were run in a traditional way, nevertheless the buffaloes had a good reproductive performance and growth rate. The buffalo farming was profitable.

Keywords | Buffalo, Farm management, Growth rate, Profitability, Reproduction

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Buffaloes are spread almost throughout Indonesia. Buffaloes are adaptive to all types of agroecosystems and have high selling values, especially for traditional ceremonies (Haloho *et al.*, 2024a). Buffaloes are environmentally friendly animals for their ability to metabolise protein better than cattle (Restitrisnani *et al.*, 2019). Buffaloes also have ability to utilise low quality feed, because they have special microbes in the rumen to ferment and utilise low digestible feeds, especially agricultural wastes with high crude fibre and low nitrogen content (Franzolin and Alves, 2010; Sarwar *et al.*, 2012). From the socio-economic point of view, buffalo farming has a positive impact on the farmers' income (Haloho and Azhimah, 2021; Haloho *et al.*, 2024a).

Central Java Province has the second largest buffalo population after West Java Province in Indonesia. In Central Java Province, buffaloes have important roles to fulfil animal protein need of the people and to help the farmers to plough paddy fields. Buffaloes also produce manure that can be used as cheap and environmentally friendly fertilizer (Kristianto *et al.*, 2019; Muatip *et al.*, 2023).

The population of buffalo in Central Java Province has been sharply decreasing. The buffalo population in Central Java Province in 2021 was 58.186, whereas in 2022 it was only 50.265 heads (Central Bureau of Statistics, 2023). There are several reasons responsible for the decline in buffalo population, namely: the function of the buffalo as the labour animal in ploughing paddy field is replaced by machines, calf mortality rates shortly after birth and before weaning is high, the grazing area is getting limited due to land conversion (disruption of the buffalo ecosystem) so that the availability for buffalo decreases, and imbalance between meat demand and availability of the buffalo (Kristianto *et al.*, 2019; Rahmat *et al.*, 2019). A study by Suryanto *et al.* (2002) showed that the buffaloes in Central Java was fed by low quality diet, i.e. grass and/or rice straw merely without any other feedstuff of high quality such as concentrate. Suryanto *et al.* (2002) also found that the buffaloes were not managed properly; the female buffaloes were not observed for their reproductive performance, so that they had the first calving at the age of 40-44 months and their calving interval was 17-21 months.

The problem of the declining buffalo population in Central Java Province has to be overcome to increase the availability of red meat. Therefore, condition and problems of buffalo farming in this province has to be discovered, then the solution can be taken.

Parallel with the increase of the human population in Central Java Province, the demand for red meat of this prov-

ince also increases. It gives big opportunity for farmers to develop buffalo business in Central Java Province, so that the population can be increased and enhance the farmer's income. However, some challenges in feed availability and quality, labour, and capital ownership of the farmers that influences the scale and prospect of buffalo farming in Central Java. Therefore, several things need to be considered, especially the availability of natural resources and the ability of farmers to develop their buffalo business in Central Java Province.

Studies on management of buffalo farming and the sustainability of buffalo business in Central Java Province, Indonesia, are still very limited. This study was aimed to investigate the management and production aspects, and business feasibility of buffalo farming in Central Java Province, Indonesia.

MATERIALS AND METHODS

LOCATION AND RESPONDENTS

This study was conducted using a survey method. The locations of this study were 7 regencies with the highest population of buffalo in Central Java Province, namely Brebes, Tegal, Pemalang, Kendal, Kudus, Magelang and Banyumas. In each regency, 2 districts were chosen as sample areas based on the geographical such as mountain and low land, so that they represented the entire regencies; so that there were 14 districts as sample areas. In each district 50-60 buffalo farmers were chosen as respondents. The respondents were buffalo farmers who had experience at least 3 years in raising buffalo, and they had cow buffaloes that had given birth twice to obtain data of calving interval. There were 380 buffalo farmers taken as respondents (50-60 respondents were taken from each regency).

SAMPLING STRUCTURE

7 regencies (Brebes, Tegal, Pemalang, Kendal, Kudus, Magelang, Banyumas) →



14 districts (2 districts in each regency)



380 respondents (25-30 respondents in each district)

PROCEDURES

The primary data including raising management, productivity and economic aspects of buffalo farming, were collected through interviews with respondents and direct observation in the field. The interviews were conducted based on the prepared questionnaires containing open questions. The data collected consisted of management of raising buffalo, including number of buffalo kept, feeding practice, health care, handling, reproduction, business management,

and financial aspects. Primary data on buffalo productivity observed included cow buffalo productivity and buffalo growth rate.

The number of buffaloes kept by the respondents was calculated in animal unit (AU). An adult bull or cow buffalo was considered as one AU, a buffalo bullock or heifer buffalo was considered as a half AU, and a buffalo calf was considered as a quarter AU.

The growth rate of buffalo was observed using a cross-sectional comparison method, which was comparing the body sizes of buffaloes at various ages at the same time. The buffaloes measured were taken randomly without taking into account the rearing management applied to them. The data of body size were obtained by measuring heart girth, body length and shoulder height. Heart girth (HG) was the body circumference just behind the elbow. Body length (BL) was the distance between the shoulder joint and the rump bone. Shoulder height (SH) was the perpendicular distance from the highest point on the shoulder to the ground where the feet were standing.

The economic analysis was carried out by collecting data of the animal stock the year before, sales in one year, purchase in one year, the current stock in the pen, operational cost, capital and investment from each farmer, and depreciation of the housing and equipment. The economic analyses were conducted by established methods, namely return on investment (ROI), benefit cost ratio (BCR), and break-even point (BEP).

The data were collected by observation and interview with 380 respondents, who were selected for having buffalo farming experience at least 3 years. The respondents' identities were collected by interviewing the respondents for age, education, number of buffaloes owned, length of experience in buffalo farming, feeding practice, and management of reproduction. Reproductive performance of cow buffalo was obtained by interviewing respondents about their buffalo cows that had given birth twice. The parameters consisted of age at the first birth, mating method, and calving interval.

The growth rate of buffalo was obtained by cross-sectional comparison method, namely comparing the body sizes of buffalo of various ages at the same time (Julianti and Nisa, 2013). The growth rate of the measurements was carried out by measuring 3 parameters, namely heart girth, shoulder height and body length, which were considered to represent aspects of increase in volume and body size of the buffalo. Heart girth was measured using a measuring tape by wrapping it around the chest just behind the elbow. Body length was measured using a measuring stick by measuring from the shoulder bulge to the bone plate. Shoulder height

was measured using a measuring stick from the highest point on the shoulder to the ground perpendicularly.

The economic feasibility of buffalo farming business was calculated through Production Cost, Revenue, Profit, Benefit-Cost Ratio (BCR), Return on Investment (ROI), and Break Even Point (BEP), which were calculated according to Santoso *et al.* (2023) and Haloho *et al.* (2024a) formulae as follow:

Revenue = (The value of buffalo stock this year – the value of buffalo purchased in one year + the value of buffalo sold in one year) – The value of buffalo stock last year.

Production cost = Value of cost production in one year.

Net profit = Revenue – Production cost.

Investment = Total capital for investment.

$$BCR = \frac{Revenue}{Production\ cost}$$

Criteria:

BCR < 1, meant that the revenue was lower than the production cost, then the business was not profitable.

BCR > 1, meant that the revenue was higher than the production cost, then the business was profitable.

$$ROI = \frac{Net\ profit}{Investment} \times 100\%$$

BEP was obtained by regression of number of buffalo raised on the axis and the profit on the ordinate. BEP was the point on axis where the profit was on the zero point.

RESULTS AND DISCUSSION

RESPONDENTS' CHARACTERISTICS

The characteristics of the respondents are presented in Table 1. The results showed that most of the respondents (86.9%) were in the productive working age (25 – 65 years). This was closely related to strength for working. Ukkas (2017) found that 15 – 64 years of age were productive. The finding by Haloho *et al.* (2024b) showed that the most of farmers in West Sulawesi Province, Indonesia, aged 27 – 59 years. Age greatly influences people's performance. (Ukkas, 2017) found that the age of workers greatly affected the quality of work, workers of the older age had a lower the performance than the younger ones; so that the older people have lower productivity at work. Vu and Tiep (2024) stated that a person's performance was influenced by several factors, including ability, gender, health, and age.

The majority of respondents (89.2%) only received elementary school education (46.3%), not finish elementary school (27.4), or never went to school (15.5%). The low education

level of the respondents caused them to only have limited capability in analysing the condition of their farms. The low education level caused the respondents to have limited horizon in farming business; they did not have open mind to accept new knowledge and technology in animal farming.

Table 1: Buffalo farmers' profile in central java province.

Age of the farmers (year)	Number	Percentage (%)
< 35	19	5.0
35 – 44	56	14.7
45 – 54	118	31.1
55 – 64	137	36.1
> 65	50	13.2
Education		
No formal education	59	15.5
Unfinished elementary school	104	27.4
Elementary school	176	46.3
Junior high school	22	5.8
Senior high school	18	4.7
Bachelor	1	0.3
Buffalo farming experience (year)		
3 – 10	93	24.5
11 – 20	138	36.3
21 – 30	102	26.8
> 31	47	12.4
Main job		
Crop farmer	140	36.8
Hodge	112	29.5
Pure buffalo farmer	87	22.9
Others	41	10.8
Number of buffalo owned (Animal Unit)		
< 3	197	52.0
3 - 5	140	36.9
6 - 10	32	8.4
11 - 15	9	2.2
More than 15	2	0.4
Time spent for rearing buffalo (hours/day)		
< 3	46	12.0
3 - 6	283	74.5
7 - 10	36	9.5
More than 10	15	4.0

On the other hand, the respondents were very experienced in raising buffalo; 75.5% of respondents had been raising buffaloes for more than 10 years. The long experience made the respondents were very skilful in handling buffaloes. This finding was similar to the results of study of Haloho *et al.* (2024a) that 80% of farmers in West Sulawesi Indonesia

had more than 10 years experiences in raising buffaloes. A study by Viviani *et al.* (2021) found that the performance of older workers was better than that of the younger ones. It was due to the older workers were more experienced in their work. Older farmers were expected to be more skilful in raising their buffaloes. The level of education of farmers affects work productivity, the higher a person's education, the broader his/her horizons and the easier he/she absorbs and accepts input or technological changes to support the livestock production. Cheng *et al.* (2022) stated that someone who has a higher education has broad insights. Farmers need to be equipped with knowledge and experience to be able to manage their livestock business. Umela (2015) stated that farmers needed to have knowledge and experience obtained through formal, non-formal education, training, and certain experiences.

Most respondents (77.1%) made buffalo farming as their side job, and only 22.9% respondents made buffalo farming as their main job (Table 1). This study showed that the main job was highly positively correlated to the spent time for raising buffalo. Every day, the majority of respondents (74.5%) spent 3 – 6 hours (averaged 4,75 h/d) for raising buffaloes. Isyanto and Agus (2015) found that working time of cattle breeders spent their time for raising their cattle was 2.14-5.10 hours/day, with an average of 3.65 hours/day. Yuniawan and Isyanto (2015) also found that number of cattle owned and main jobs of the breeder had a positive and significant correlation on the working time in beef cattle fattening businesses.

This study showed that at least 52% of respondents had less than 3 AU buffaloes, and only a very small number of respondents (0.4%) had more than 15 AU buffaloes. Haloho *et al.* (2024a) found that buffalo ownership in Indonesia was highly influenced by the parents's inheritance. The more buffaloes being inherited from the parents, the more buffaloes owned by the farmers. The small scale of buffalo farming in Central Java Province caused by the limited capital owned by the respondents as buffalo breeders. This implicated that the respondents were faced difficulties in developing their buffalo business. An effort to develop the buffalo farming requires financial aid to the farmers such as soft loan for increasing the farming scale.

REARING

FEEDING MANAGEMENT: As shown in Table 2, the feeding management of buffalo in Central Java Province was extensively and semi-intensively. The buffaloes were grazed from the morning to the evening, then the buffalo were reared in the cage at night. The main feedstuffs given to the buffaloes in the cage were wild grass, rice straw and/or agricultural wastes. There were 50.3% respondents provided wild grass and rice straw, 40.3% respondents provided wild grass and agricultural wastes, and only 5% of

farmers provided cultured grass to support buffalo growth. It indicated that the farmers of buffalo in Central Java Province used traditional feeding management. This was due to the most of the farmers also work as crop farmers (Table 1), so they used agricultural wastes as buffalo feed. This study also found that respondents had no technology and enough knowledge in the nutrient requirements of the buffalo. The low education, limited knowledge and limited capital owned caused the respondents did not give concentrate to their buffalo. This, in turn, caused the productivity of the buffalo to be low.

Table 2: The feed given for buffalo in central java province.

Feed given	Number	Percentage
Rice straw	7	1.8
Rice straw and wild grass	191	50.3
Rice straw and cultured grass	5	1.3
Wild grass	10	2.6
Wild grass and cultured grass	3	0.8
Rice straw, cultured grass, wild grass	11	2.9
Wild grass and other agricultural wastes	153	40.3

The results of this study showed the buffalo farmers relied on the wild grass and agricultural wastes to support the availability of buffalo feed. These feedstuffs had low quality and it contributed to low productivity of the buffaloes. This was parallel with the finding of Rusdiana *et al.* (2020) that most farmers relied on wild grass and agricultural waste and only a few farmers used cultured grass or supplementary feed such as concentrate for their buffaloes low feed availability and inefficient feeding also resulted in low reproductive performance and production of buffaloes due to delayed oestrous cycles, longer calving intervals, and low growth rates (Deb *et al.*, 2016). Improvements in nutritional quality of the feed should be done to increase the buffalo productivity. It can be done by concentrate supplementation.

Table 3: Reproductive performance of buffalo.

Mating method	natural
Age at first calving (year)	3.3
Calving interval (month)	19.8
Age at weaned (month)	8.2

REPRODUCTIVE MANAGEMENT AND PERFORMANCE: The reproductive performance of buffalo cows in Central Java Province is presented in Table 3. All respondents used natural mating method for their buffalo cows Java Province. It was caused by several things. Firstly, the presence of silent heat in buffalo making the breeders found difficulty to detect the oestrous buffalo. Secondly, the technology of artificial insemination in buffalo was not widely known by the breeders.

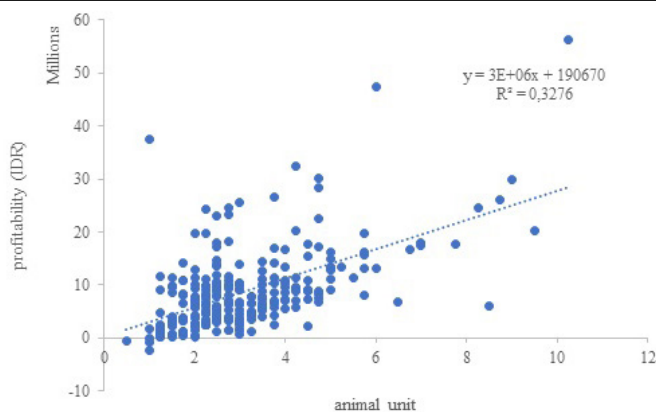


Figure 1: Correlation between ownership of buffalo and profitability.

Age at first calving of buffalo was 3.3 year. This study was similar to the study of Jainudeen (2002) that a cow buffalo gave birth for the first time at the age of 3-5 years and go through a gestation period of 43 – 45 weeks, and gave birth to two buffalo calves in 3 years. Fitriani *et al.* (2023) claimed that the swamp buffalo gave the first birth at older age than the cow. It was due to the buffalo reached its puberty in the older age and had longer gestation period than the cow. In the other hand, calving interval in this study was 19.8 month. This time was longer than study of Fitriani *et al.* (2023). Calving interval of local buffalo in Indonesia was more than 15 months (Haloho *et al.*, 2024b). A successful breeding depends on the ability of the cow buffalo to give birth in a certain period; shorter calving interval results leads to more buffalo calves produced during the lifetime of the cow, and its reproductive performance was better (Yendraliza *et al.*, 2021). It might also was caused by the weaning system in buffalo farming. An average of weaned calve was 8.2 month. The sooner the buffalo was weaned, the sooner the buffalo would return to oestrus. A finding by Kamal *et al.* (2014) showed that suckling in long time have a higher risk of postpartum anoestrus than non-suckling buffalo. Most of the farmers did not have knowledge and skill in reproduction management. Therefore, extension and training in reproduction management should be done.

GROW RATE OF THE BUFFALO

The growth rates of female and male buffaloes are presented in Figure 2 and 3. For both males and females, the buffalo accelerated growth starting from the birth until they reached maturity. The body length, body height and heart girth of the female buffalo reached the maturity growth at 12 -15 months of age. The body length, body height and heart girth at this age were 100 - 120 cm, 100 - 135 cm and 220 - 250 cm, respectively. After reaching maturity, growth gradually slowed down sharply.

According to Grant and Helferich (1991) there are two phases of growth. In the first phase, the growth of bones

and muscle tissue is accelerated until puberty and triggered by the presence of growth hormone. Secondly, after puberty, growth slows due to the increased action of steroid hormones which increase the deposition of adipose tissue. Luthfi *et al.* (2024) and Rianto *et al.* (2024) found that in the growth process (youth), bones were body tissue that grew quickly and reached maturity earlier, followed by muscles and fat. This study also confirmed Owens *et al.* (1993), who showed that livestock growth exhibits a sigmoid curve, where growth accelerated until puberty, and an inflection point could be observed, and then became slower until maturity.

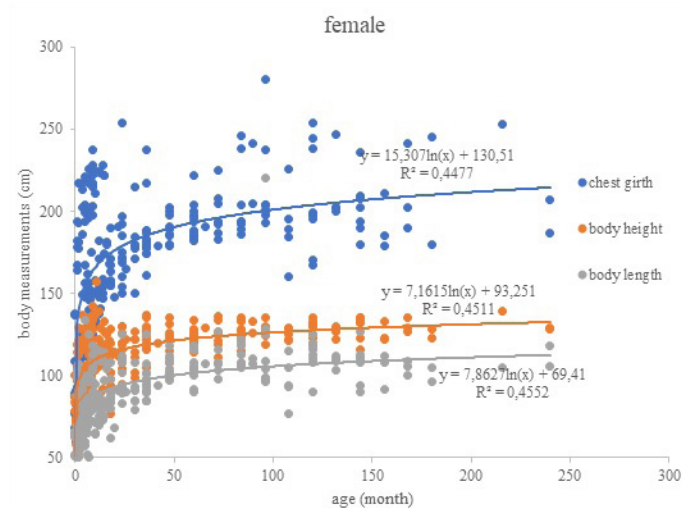


Figure 2: Growth of female buffalo.

This also happened to male buffalo. The buffalo accelerated growth starting from birth until reaching maturity. However, the body length, height and heart girth of male buffalo reached a peak growth faster than females, namely at around 8 - 10 months of age. Body length, height and heart girth of female buffalo reached peak growth of 90 - 100 cm, 100 - 120 cm and 190 - 220 cm, respectively. Then when it reached maturity, growth gradually slowed.

The graphs of growth rates of the male and female buffaloes were constructed from the data of body measurements of buffaloes that were taken randomly in the field. Nevertheless, the fact that the feeding management applied was almost the same among the respondents, the graphs were reliable to predict the growth rate of the buffalo in Central Java Province. McDonald *et al.* (2010) stated that given the same genetic quality, and similar environmental condition, feeding management is the main factor influencing the growth rate of animals.

THE FEASIBILITY OF BUFFALO FARMING

Analysis of buffalo business is presented in Table 4. The average investment buffalo business in Central Java Province was 76,687,319. This investment consisted of buffalo and housing, i.e. IDR 30,873,940 and IDR 45,813,379, respectively,

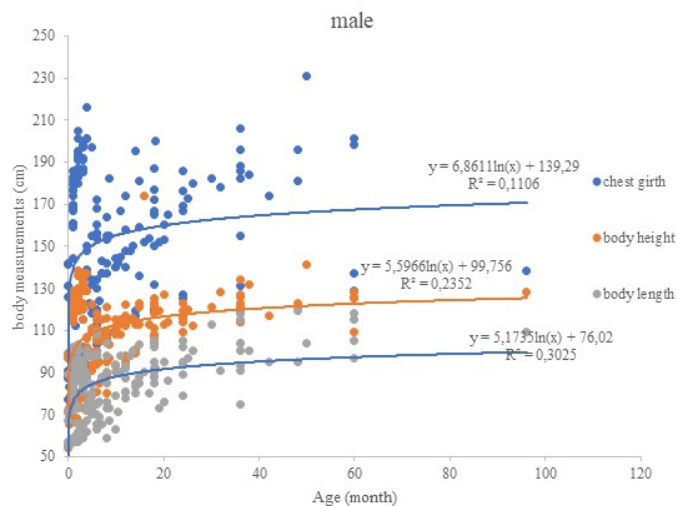


Figure 3: Growth of male buffalo.

The average of revenue in this study was IDR 13,352,148 per year. The revenue was greatly affected by the body weight gain of the buffaloes and the buffalo calves born. The revenue was a major factor in the net profit received by the farmers. The net profit in this research was IDR 7,947,998. The profit was affected by total cost production and revenue. There were 2 kinds of cost, i.e. fixed cost and variable cost. The fixed cost consisted of cage depreciation and equipment depreciation cost, and the variable cost consisted of labour and medicine. The farmers did not spend money for feed, because the feed was obtained from the surrounding environment, however the labour used to collect the feed had to be paid.

The average of benefit-cost ratio of buffalo business in Central Java Province was 2.47. It indicated that every IDR 1 production cost induced IDR 2.4 net benefit. This finding showed that the business of buffalo in Central Java Province was profitable. Santoso *et al.* (2023) claimed that business of livestock could be feasible to run if the value of the BCR was higher than 1. Haloho *et al.* (2024a) found that BCR of buffalo business in West Sulawesi Province, Indonesia, was 1.25.

This study found that ROI of buffalo business in Central Java Province was 12.13. It indicated that every IDR 100 invested resulted in benefit at amount of IDR 12.13 per year. The value of ROI in this study was greater than the deposit interest rate of Indonesian Bank (6%). Since the capital used in this business was entirely the farmers' own, it was considered that this business was profitable. The value of ROI in this study was lower than the finding of Haloho *et al.* (2024a) that ROI of buffalo business in West Sulawesi was 53.4%. Haloho *et al.* (2024a) found that the production cost of buffalo business in West Sulawesi was very low, while the investment was also relatively low, causing the ROI to be high. Haloho *et al.* (2024a) did not take into account the working time of the farmers to raise the

buffalo as labour that should be paid, while this study took into account the working time of the farmers as labour that should be paid. The factual income of the farmers came from the salary as the labour and the net profit of the business, i.e. IDR 12,863,123.

The results of this study also showed that this buffalo farming promised profits. Figure 1 shows a close and positive relationship between the number of buffalo ownership and the profits obtained by buffalo farmers. Owning 1 AU buffalo provided profit at amount of IDR 190,670. There was no minimum number of buffalo had to be raised to obtained benefit. It also indicated that raising buffalo in Central Java Province was profitable, so that it was feasible to run. However, the profit obtained from this business was considered to be low. This was due to the practice of the buffalo raising was still run in traditional way, in which the input of the production was minimum. Therefore, beside maintenance management, the amount and quality of the feed should be considered in order to support buffalo production and increase the profit. The availability of feed and good nutritional intake would increase growth rate and reproductive performance of the buffaloes, which in turn would reduce the overall production costs such for feed, labour and maintenance (Luthfi *et al.*, 2022; Luthfi *et al.*, 2023; Aluns and Luthfi, 2018).

Table 4: Economic analysis of buffalo business.

Investment	65528582
Buffalo	54029395
Housing	11253897
Equipment	245290
Fixed cost (IDR/year)	611753
Animal housing depreciation	652595
Equipment depreciation	49058
Variable cost (IDR/year)	4988782
Medicine	73657
Labour	4915125
Total cost (IDR/year)	5404150
Revenue (IDR/year)	13352148
Net profit (IDR/year)	7947998
ROI	12,13
BCR	2,47

CONCLUSIONS AND RECOMMENDATIONS

Based on the results, it can be concluded that buffalo farming in Central Java was done in a traditional way. Nevertheless, it was profitable. The buffaloes in Central Java had a good reproductive performance and growth rate. Buffalo farming gave profit to the farmers at amount of IDR 190,670/ AU in a year. There should be capital aids and

extension for the buffalo farmers to increase the business scale and improve the feeding management of the buffalo, so that the productivity of the buffalo and the income of the buffalo farmers can be increased.

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NOVELTY STATEMENT

The authors declare that there have been very limited study about the topic presented in this paper.

AUTHOR'S CONTRIBUTIONS

Study design: Edy Rianto, Sutaryo Sutaryo, Vita Restitrisnani, Sri Mawati. Data collection and tabulation: Muhammad Hesa Karim, Putty Kinanti Anif Machfiroh, Niar Ulfa, Agnes Ragil Mustikasari, Dwi Wahyu Setiawan, Farkhan, Marcelinus Dwi Septian, Vita Restitrisnani. Edy Rianto. Data Analyses: Edy Rianto, Sutaryo Sutaryo, Vita Restitrisnani, Agung Purnomoadi, Endang Purbowati, Retno Adiwindari, Nadlirotun Luthfi. Paper writing: Edy Rianto, Nadlirotun Luthfi.

CONFLICT OF INTEREST

The authors declared that there was no conflict of interest in this study.

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