

The effect of upstream production on corn supply chain sustainability as broiler feed

by I Rasyid

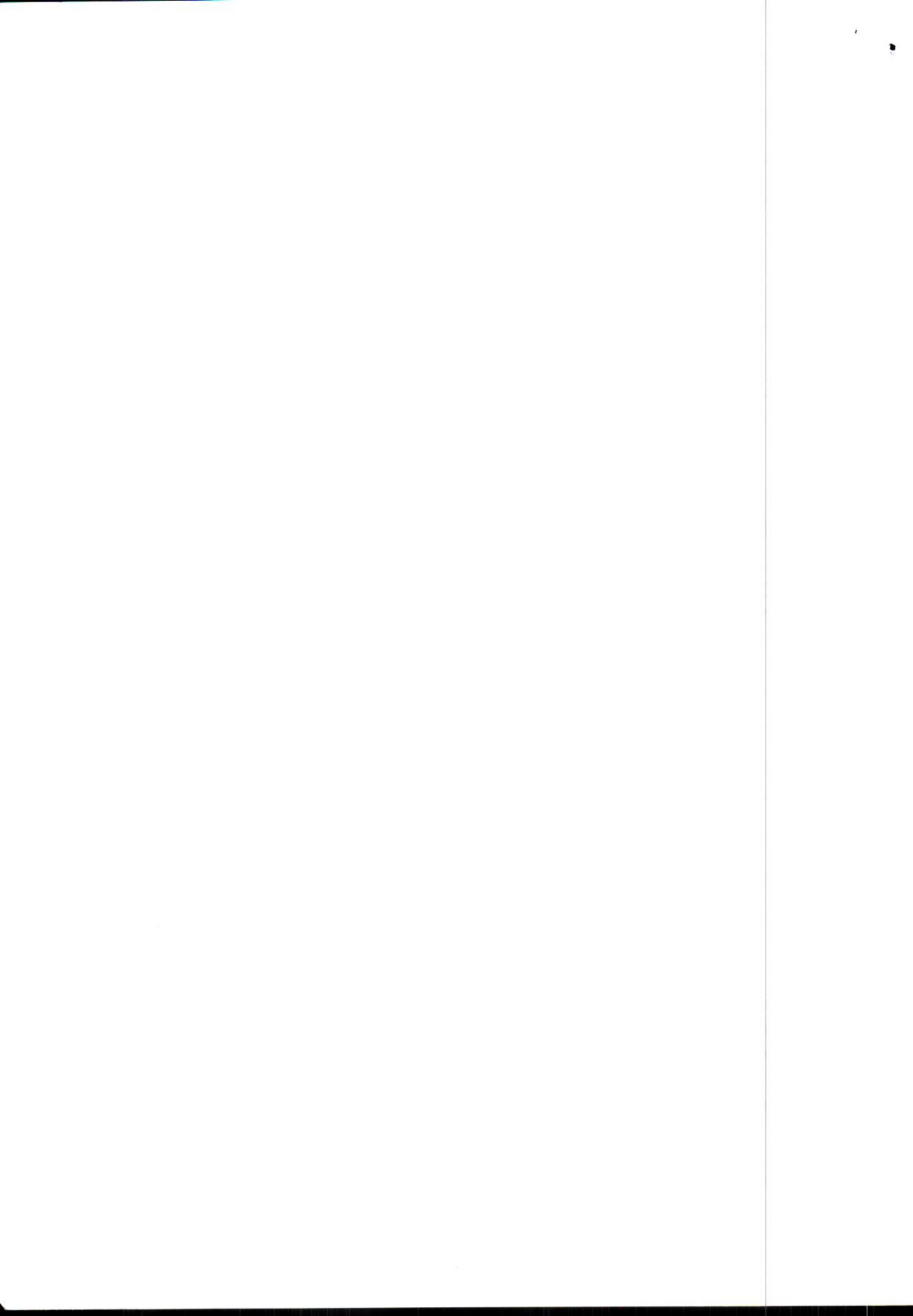
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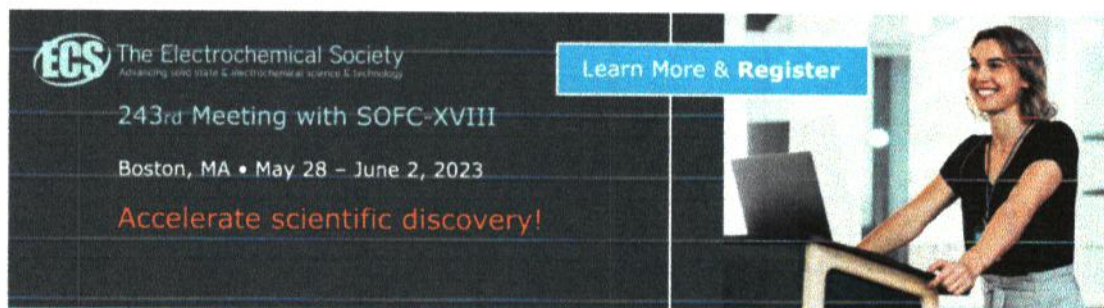
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The effect of upstream production on corn supply chain sustainability as broiler feed

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Abstract. The study aimed to identify the scheme of farmer productive factors that may give an impact on the supply chain sustainability as the upstream feedstuffs producers to satisfy the feedstuffs demand of the broiler feed industry. Collected data were analysed using descriptive statistic. This study was categorized as a descriptive quantitative study. The results of the study showed that one effective productive factor from the farmer respondents was corn farming experience. On the other hand, other productive factors including land area, corn Sheller and dryer facilities and agricultural capital were not prominent. Therefore, in order to sustain the corn supply chain from the farmers or upstream supply chain, the primary factors that should be fulfilled included the agricultural capital, land area, and corn Sheller and dryer. The productive factors of agricultural capital, land area, and corn Sheller and dryer, as well as the knowledge in farming, were determining in sustaining the corn supply chain sustainability to fulfil the demand of either final consumer or broiler feed industry.

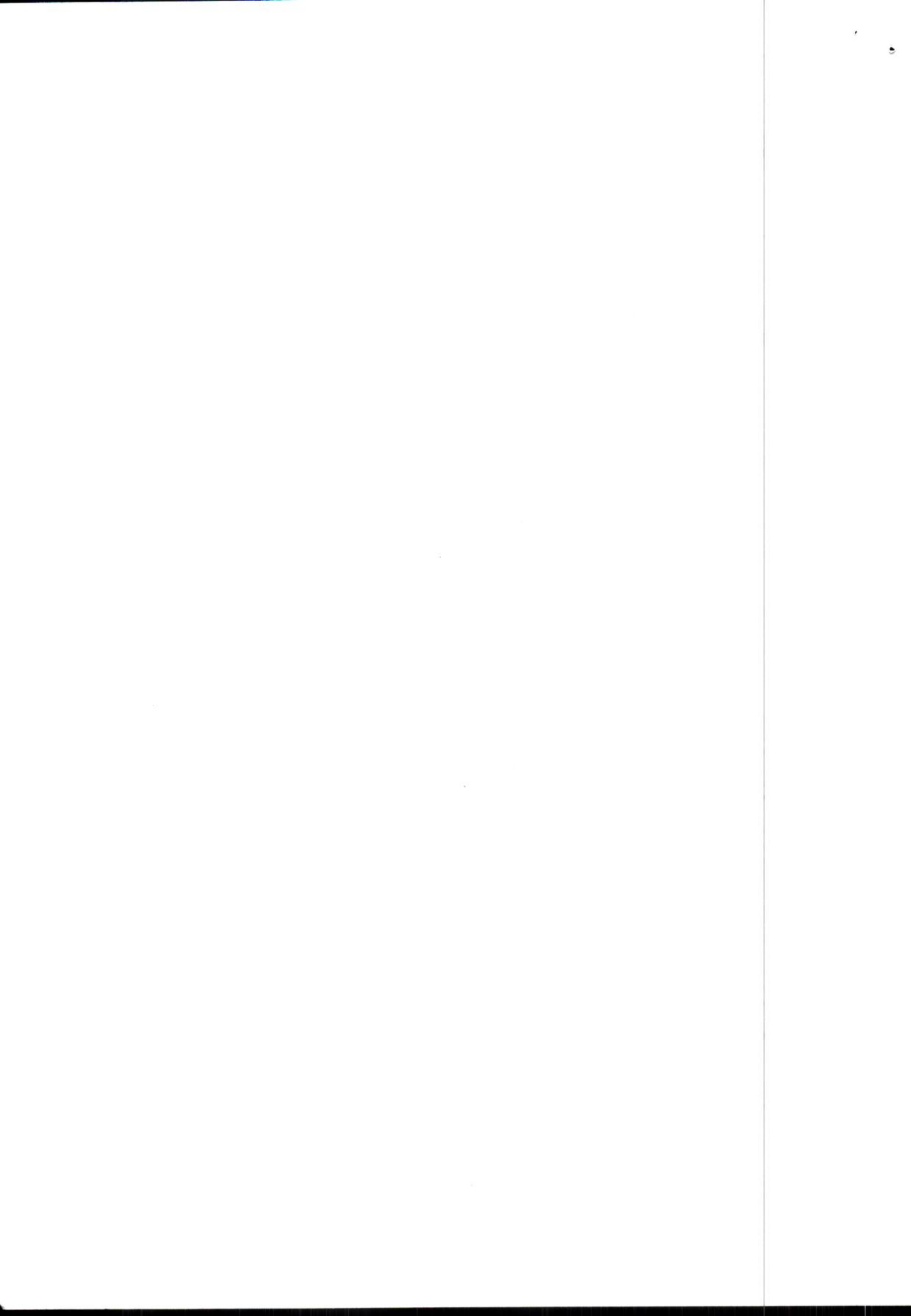
1. Introduction

The dominant use of imported corn as feedstuff in the broiler feed industries is still evident. The industry still cannot rely on the supplied corn feedstuff by the farmer as the upstream supply chain since broiler feed industry set the requirements of moisture content quality, fungal contamination, the volume demand, and feedstuff accurate arrival cannot be completely fulfilled by the rural farmers.

Consequently, the sustainable corn supply chain is difficult to establish since the primary issue of the supply chain is related to the upstream factor or the farmer itself. In the broiler feed industry, the issue of quality or high volume demand on corn supply is estimated to be the cause that affects the productive factor availability. Therefore, an analysis is considered to be necessary. Corn quality in terms of moisture content and fungal contamination could be solved by providing productive factors such as corn dryer and by upgrading the farmer's knowledge on corn farming [1]. Study of Rizka et al [2] stated that the productive factors that significantly affected the corn farming were agricultural capital for seed, agricultural machinery, pesticide, labour, land leasing and fertilizer costs. It was also confirmed that corn production was significantly affected by certain variables including the quantity of seed, pesticide, and labour. Other variables including land area and the amount of fertilizer did not significantly affect the productive factors. Kaliba et al [3] stated that the variables affecting corn productive factors significantly included land, fertilizer, and seed. In contrast, labour did not significantly affect the productive factors. The motivating factors in corn production were land area, capital, fertilizer, and labour [4]. Tomy [5] revealed that seed quantity significantly affected corn

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production. On the other hand, land area, fertilizer, and labour did not significantly affect corn production. Budiono et al [6] stated that productive factors such as land area, labour, seed, and urea fertilizer significantly affect corn production. On the other hand, manure, phonska fertilizer and herbicide did not significantly affect the corn production. Purwanto [7] concluded that the variables including land area, seed, fertilizer, and labour significantly affected the corn production. The average income of the farmer respondents in Modo Village corn hybrid farming was IDR.5.984.661 per 1.18 acres or IDR.5.071.746,00 per acre in a harvest season.

According to Saenong et al [8] that the seed quality was evaluated in the pre-harvest, harvest, and post-harvest period. The difference in seed lot quality (before the seed storage) may be resulted by differences in growth environment (land fertility, climate, and seed breeding method), period and harvesting method, drying, shelling, cleaning, grading, packaging, and distribution. Widaningrum et al [9] in a study concerning the corn post-harvesting method by using Carbon Dioxide (CO₂) with three distinctive concentration rates (0%, 40%, and 70%) and four different storage periods (2, 4, 6, and 8 weeks) concluded that CO₂ concentration affected the moisture content and corn kernel crude fibre. However, it did not affect the ash, lipid, protein and starch content. Therefore, Storage method by using Carbon Dioxide was recommended to apply on the corn kernel during the storage period due to its capability in preserving corn kernel nutritional content compared to corn kernel processing without Carbon Dioxide (CO₂) treatment. Polypropylene is the primary packaging for unpeeled corn during the storage and distribution period [10]. A study has been conducted that there were significant differences in the parameters of conductivity, 100-grain weight, germination energy, vigor index, germination synchrony, normal dry weight of shoot after a storage period of 4 months. Genotype MDR 18.5.1, DR 17, 4 BR 157, 4 MDR 14.1.1 is a genotype with seed storability after a period of 4 months [11].

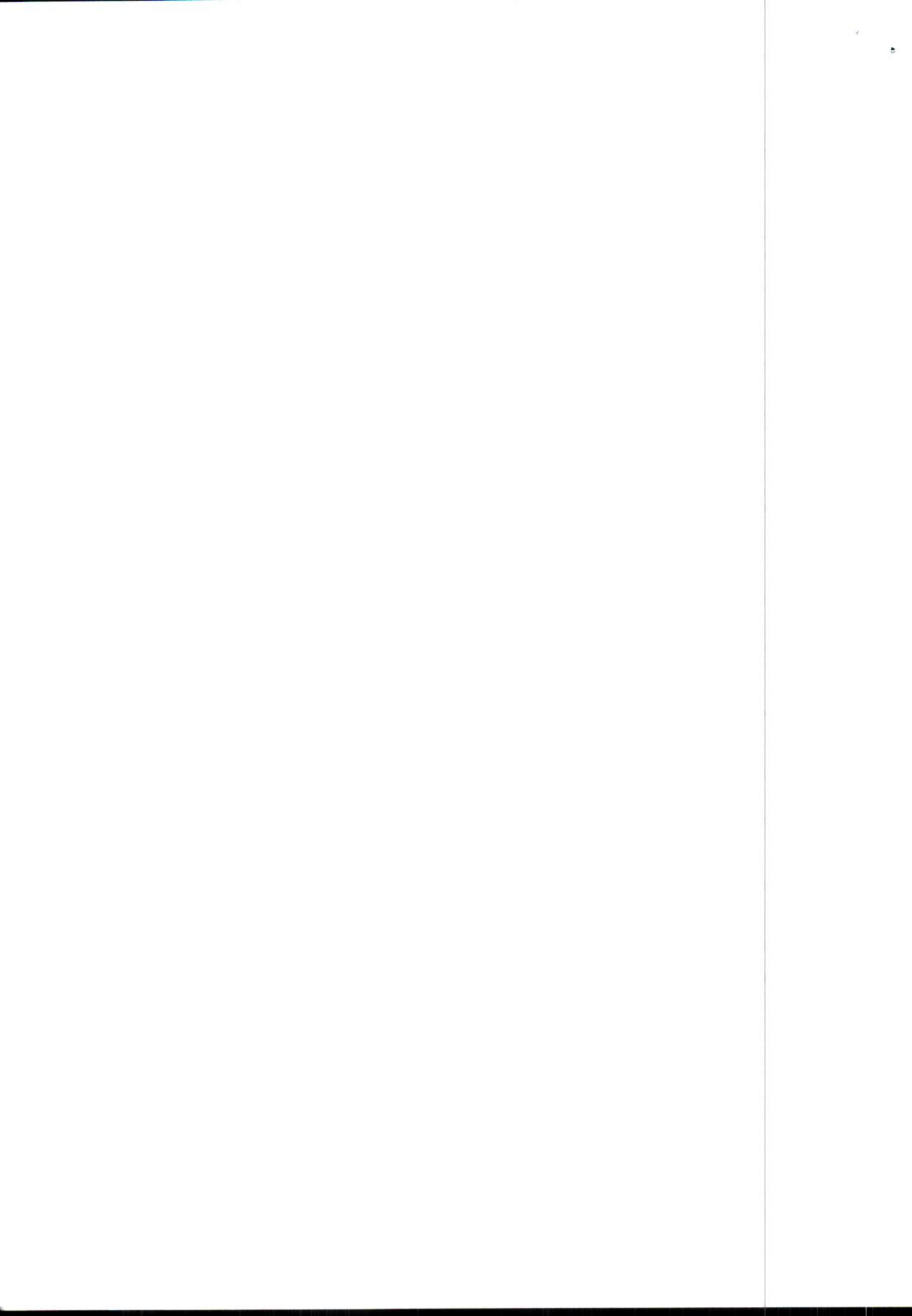
Based on the above description, by observing the rural corn farmer characteristics, indicators such as seed selection through conductivity and seed storability employing carbon dioxide (CO₂) were included in the variable of farmer's knowledge, while land area variable included land ownership indicators of 1.51 - 2.00 acres, 1.01 - 1.50 acres, and 0.50 - 1.00 acre. The micro indicators of capital variable consisted of IDR 4,000,000.00 (two million rupiahs), IDR 4,000,000.00 - 8,000,000.00, and > 8,000,000.00 for one season. Similarly, the indicators of corn Sheller and dryer ownership variable consisted of individual ownership, leasehold ownership and no ownership.

The interesting part of this study was grounded on the fact that the higher the volume produced by the farmer supported by numerous factors such as good knowledge, corn Sheller, corn dryer, land ownership and capital, the more convincing the sustainability of corn supply chain due to supporting upstream factors towards volume availability and corn quality. This study provided a solution to the problematic phenomena addressed by the farmer in the rural area and feed industry at once. In addition to this background, this study also aimed to provide a schema of productive factors from the farmers which impacted the supply chain sustainability as upstream feedstuff producer to fulfil the feedstuffs demand of broiler feed industry.

2. Study method

This study was performed in South Sulawesi Province, Gowa Regency, Bontonompo Sub-District as the representative of other sub-districts in Gowa. This site was selected due to homogenous characteristics experienced by the corn farmer. A total of 30 farmer respondents were selected by purposive sampling. The respondents, then, interviewed through a questionnaire by the assistance of an enumerator in guide the respondents filling the questionnaire. Prior to data collection, in order to determine the variable and study indicators, a focused group discussion (FGD) was performed. The results from data collection were analysed using descriptive statistical analysis since the characteristic of the data was qualitative while the study type was considered as quantitative descriptive. Therefore, qualitative data were quantified by employing Likert scale score ranging from 3, 2, and 1 [2,13,14].

In determining the standard of the study variables and indicators, the grand theory grounded on the previous studies [2,8,9,11]. The grand theories from previous literature were compared with the results



of this study and therefore, theoretical implications and policy implications could be drawn from the comparison.

3. Results and discussion

3.1. Production factor of land

From the data collection of 30 respondents concerning land area ownership for corn farming to support the sustainability of the upstream supply chain in fulfilling the broiler feed industry demand, the analyzed data by using statistic descriptive analysis showed the results as presented in Table 1.

Table 1. Land area ownership for corn farming to support the sustainability of the upstream supply chain of 30 farmer respondents.

No	Land area ownership	Respondent (F)	Score	Category	Total
1.	1.51 to 2.00 acres	2	3	High	6
2.	1.01 – 1.50 acres	8	2	Medium	16
3.	0.50 to 1.00 acres	20	1	Low	20
Total		30	-	-	42

Table 1 shows that in a continuum way, the average land ownership was categorized as medium in which the total value is 42 in a range value from 30 to 60. Therefore, to support sustainable corn supply chain, the cooperation among the farmer group should be strengthened to produce required corn volume by the feed industry. The role of local government was also necessary for corn farming land expansion under the supervision of food crop agricultural service and farmer group as an organization. In a theoretical implication perspective, this supported by a previous study [15] where regression analysis showed that the land ownership of the farmer significantly affected the hybrid corn production improvement with a confidence level of 99% and alpha ($\alpha = 0.01\%$). Propositionally, it may imply that the larger the corn farming land area owned by the farmer, the higher the corn volume produced by the farmer, and the better the economic income to the farmer's family as well as the better the farmer's motivation in corn farming.

3.2. Capital ownership of corn farming

Based on the data collected from 30 respondents concerning the capital ownership for corn farming to support the sustainability of the upstream supply chain in fulfilling the broiler feed industry demand, the results of the analyzed data by using statistic descriptive analysis are presented in Table 2.

Table 2. Capital ownership for corn farming to support the sustainability of the upstream supply chain from 30 farmer respondents.

No	Capital ownership of corn farming/ planting season (IDR)	Respondent (F)	Score	Category	Total
1.	> 8,000,000.00	2	3	High	6
2.	4,000,000.00 – 8,000,000.00	9	2	Medium	18
3.	< 4,000,000.00	19	1	Low	19
Total		30	-	-	43

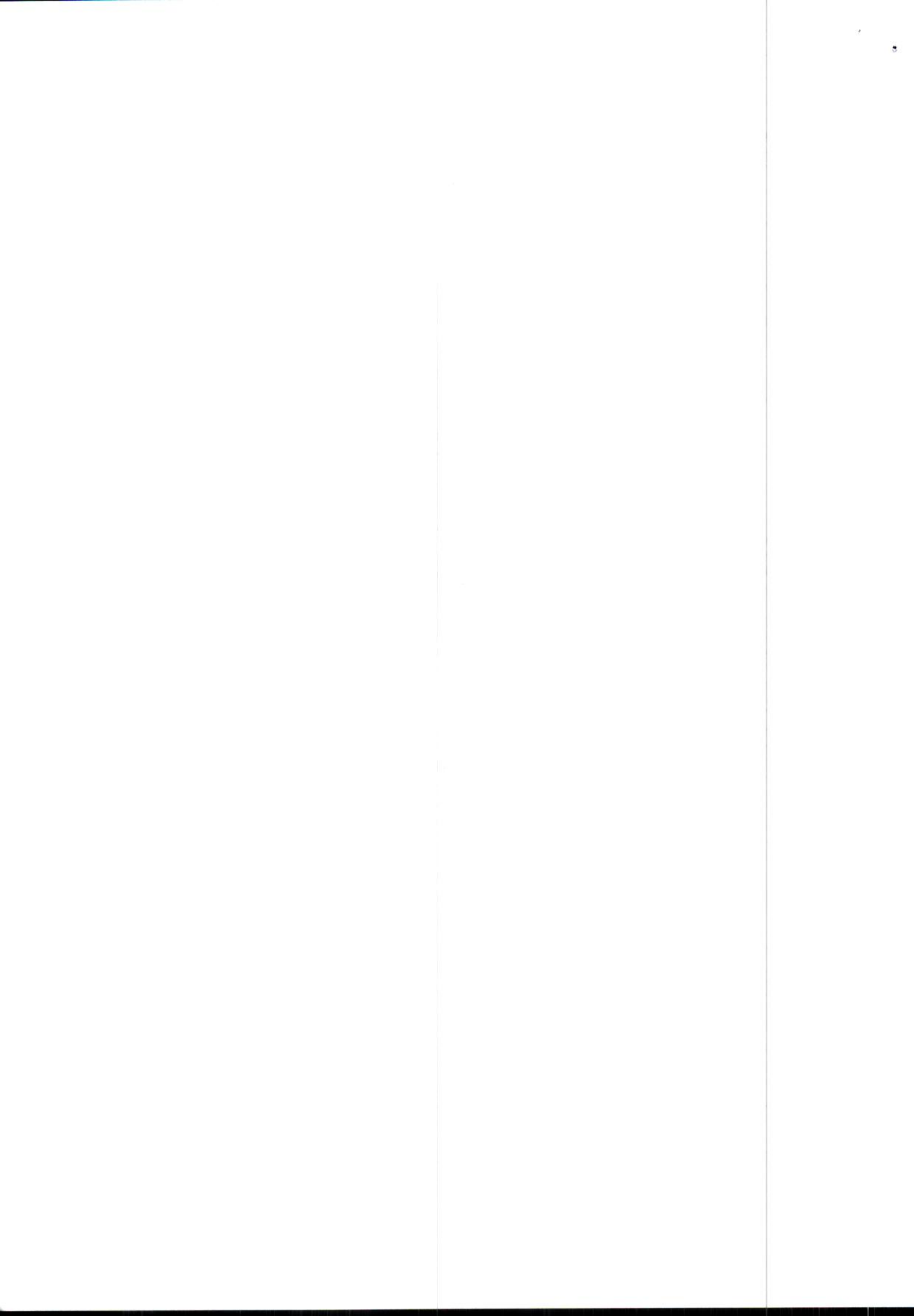


Table 2 shows that in a continuum way, the average capital ownership of corn farming/planting season was categorized as medium in which the total value is 43 in a range value from 30 to 60. Therefore, in order to support corn supply chain sustainability, the farmer group capital accommodation should be improved either from the private sector or governmental sector which in turn, will enable the farmer to purchase corn sheller and corn dryer to produce higher corn volume. Local government roles as the authority or guarantor for farming budgetary sources were also necessary in the annual allocation of local budgetary plan to support farmer capital ownership. In a theoretical implication perspective, this supported a previous study [4] where regression analysis indicated that the corn capital ownership significantly affected the hybrid corn production improvement with a confidence level of 99% and alpha ($\alpha = 0.01\%$). Proportionally, it may imply that the more powerful the farming capital of the corn farmer, the more flexible the farmer in purchasing/procuring of production factors which positively correlates with the corn production target increase, corn quality and corn farmer's motivation that impacts the farmer family income.

3.3. Farmer's knowledge of corn storage quality

Based on the data collected from 30 respondents concerning the farmer's knowledge of corn storage quality by employing carbon dioxide (CO₂) at certain degree to support the sustainability of the upstream supply chain in fulfilling the broiler feed industry demand, the results of the analyzed data by using statistic descriptive analysis are presented in table 3.

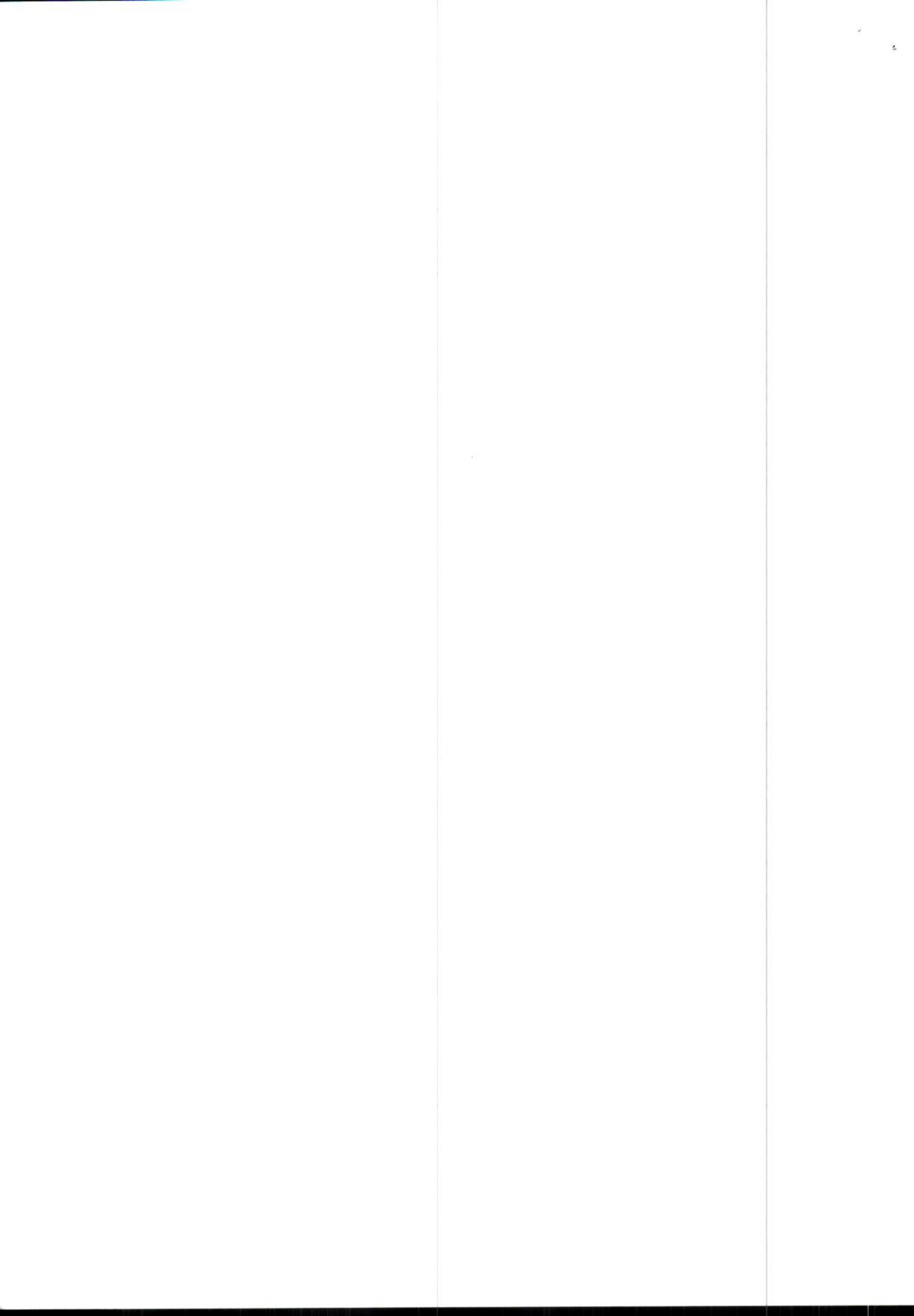
Table 3. Farmer's knowledge of corn storage quality in supporting the sustainability of the supply chain from 30 farmer respondents.

No	Knowledge	Respondent (F)	Score	Category	Total
1.	Use	0	3	High	0
2.	Have not used	0	2	Medium	0
3.	Not use	30	1	Low	30
	Total	30	-	-	30

Table 3 shows that in a continuum way, the average farmer's knowledge of corn storage quality by using Carbon dioxide (CO₂) was categorized as low in which the total value is 30 in a range value from 0 to 30. Therefore, in order to support the corn supply chain sustainability for quality factor was very low. Training the farmer to use carbon dioxide method in improving corn quality should be recommended. Local government roles to fund and support the training program in carbon dioxide use should also be accommodated. In a theoretical implication perspective, this supported a study [9] where Carbon dioxide (CO₂) use at the concentration of 0%, 40%, and 70% with 2, 4, and 8 weeks of storage period positively affect the moisture content and crude fibre in corn kernels. It is also able to preserve the nutritional composition in corn kernels compared to corn kernels without the CO₂ treatment. Proportionally, it indicated that the use of carbon dioxide in the corn storage at certain concentration may affect positively the nutrition preserve ability of corn kernels.

3.4. Corn dryer ownership of the farmer

Post-harvest management is one of the important elements in corn farming. It is related to the fact that farmers generally cultivate corn during the rainy season with high moisture and rainfall intensity. Post-harvest process of corn harvesting consists of a line-up of activities beginning with cultivation, cob drying, cob shelling, kernel packaging and storage before distributed to the collectors. Therefore, the process of drying corn kernel is necessary to fulfil the broiler feed industry requirement regarding the corn moisture content. Corn dryer is also necessary to accelerate the drying period and to maximize the efficiency of corn processing time, cost, energy, and the farmer income distribution in relation to the corn market supply. In such condition, corn dryer ownership by the farmer could boost the farming



enterprise. The results of a study [16] stated that employing corn dryer may offer the efficiency of 18 hours of the drying process with corn pile thickness of 45 cm while the sun drying method may spend time for 4 days.

With regard to the corn dryer ownership of the farmer, this study collected data from 30 farmer respondents. The aim of the ownership is to support the sustainability of the upstream supply chain in fulfilling the broiler feed industry demand. The results of analysed data by using statistic descriptive analysis are presented in Table 4.

Table 4. Corn Dryer ownership in supporting the supply chain sustainability of 30 farmer respondents.

No	Corn dryer ownership	Respondent (F)	Score	Category	Total
1.	Own	2	3	High	6
2.	Lease	3	2	Medium	6
3.	Not Own	25	1	Low	25
	Total	30	-	-	37

Table 4 shows that in a continuum way, the average corn dryer ownership for corn quality improvement was categorized as medium in which the total value is 37 in a range value from 30 to 60. It implied that there were 2 farmers owned the corn dryer (6.67), 3 farmers leased the corn dryer (10%), and 25 farmers relied on the sun-drying process (83.33%). The quality factor was categorized as nearly low. Therefore, in order to support the corn supply chain sustainability, the procurement of corn dryer through self-funding in farmer groups as an organization should be recommended. The role of local government in funding the corn dryer and providing training in using the dryer is necessary. From a theoretical implication perspective, this supported a study performed by [16] that corn dryer is very important and affect positively the production quality of corn. Proportionally, it may imply that by using corn dryer among the farmers, the quality of produced corn could accelerate the efficiency of time, cost, energy and farmer's income distribution.

3.5. Corn sheller ownership of the farmer

SENAPIL corn Sheller has an effective production capacity with fuel motor power of 7 HP [17]. When it is used to shell the corncob with diameter of 5 cm, the production would be 1.1 ton per hour, while for the corncob with diameter of < 5.0 cm and >2.5 cm, the production would be 1.3 ton per hour and 0.8 ton per hour and per two people with broken kernel percentage of 3 - 6%. Generally the farmers plant the corn in the beginning of rainy season and cultivate the corn when the rainfall intensity is still high [18]. In such conditions, there is a possibility of *Aspergillus flavus* contamination to occur that emits aflatoxin. The fungus has its optimum growth at a temperature of 26-32, kernel moisture content > 17.55%, and relative humidity of 83% - 85%.

Generally, the farmers have certain procedures in harvesting process such as cutting the comstalk, collecting the corn, peeling the husk, packaging the corn into a sack and transporting the corn to the farmer house to dry [19]. If the day is rainy, the corn will be dried under the stilt house. However, if the shelled corncob contained >20% moisture content, the kernels would most probably be broken. Broken kernels may result in increasing aflatoxin content [20,19].

With respect to the importance of corn Sheller in reducing moisture content, improving corn kernel durability and preventing the contamination of *Aspergillus flavus* that emits aflatoxin, if the farmers are unable to operate the corn Sheller for supply chain sustainability, they will not be able to achieve better production and income. Therefore, in order to solve and identify the issue of corn Sheller ownership, study was done by collecting data from 30 respondents in the research site, Gowa, South Sulawesi. The results of the descriptive statistical analysis are presented in table 5.

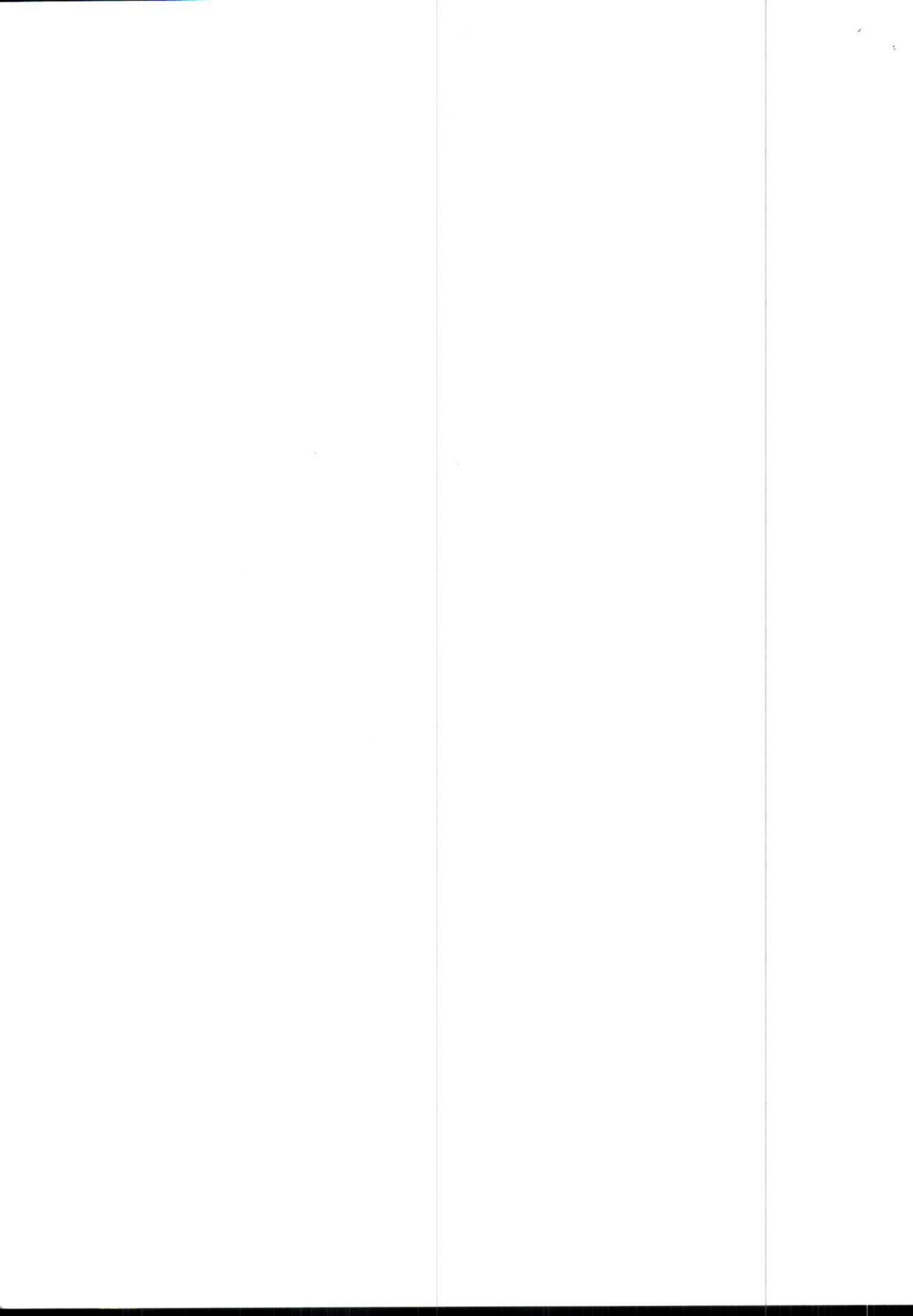


Table 5. Corn Sheller ownership in supporting the supply chain sustainability of 30 farmer respondents.

No	Ownership of corn Sheller machine	Respondent (F)	Score	Category	Total
1.	Own	2	3	High	6
2.	Lease	3	2	Medium	6
3.	Not Own	25	1	Low	25
	Total	30	-	-	37

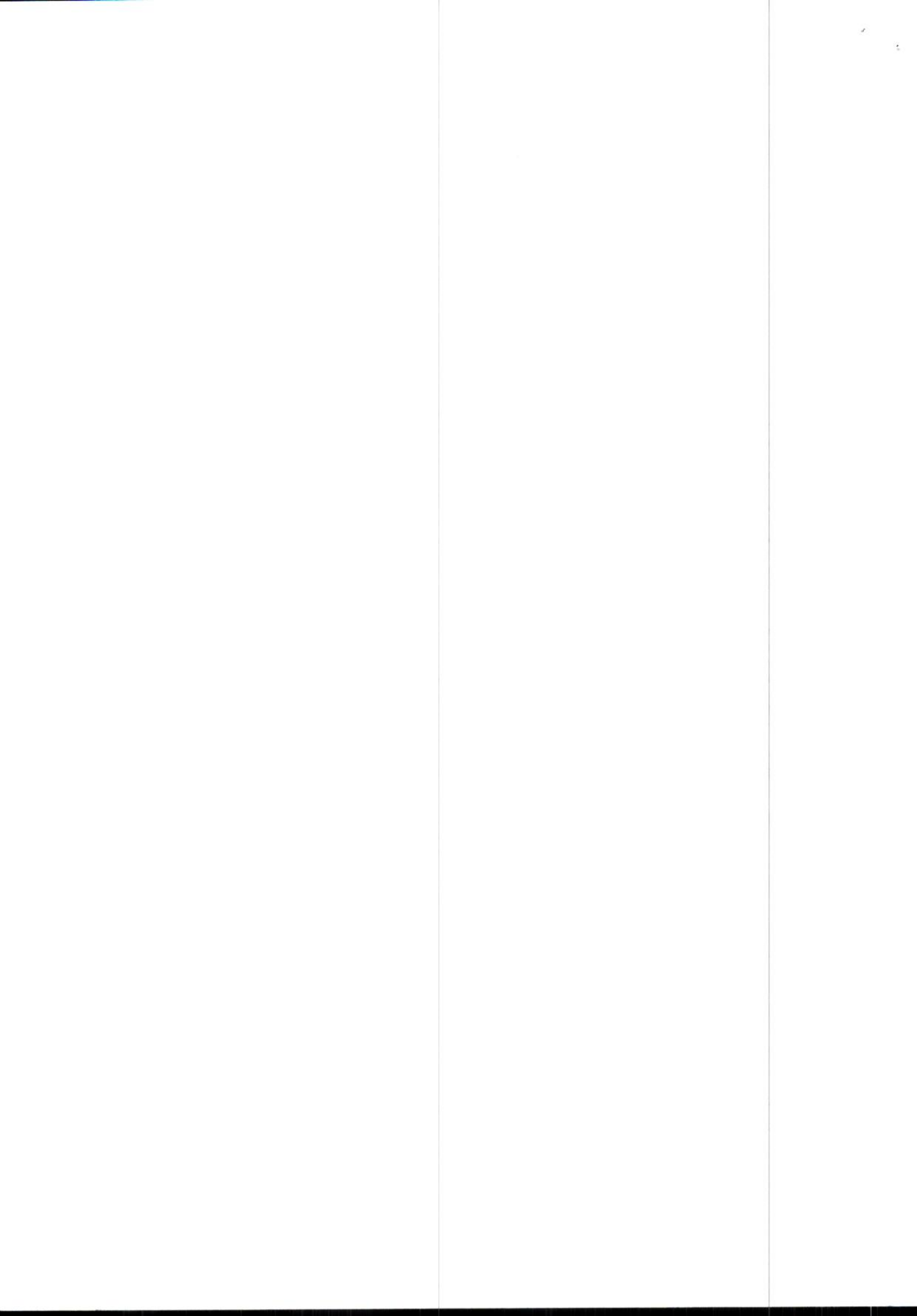
As shown in table 5, in a continuum way, it showed that the average corn Sheller ownership for improving the corn quality, preventing broken kernel and preventing the contamination of *Aspergillus flavus* emitting aflatoxin was categorized as medium in which the total value is 37 in a range value from 30 to 60. This implied that only 2 farmers owned corn Sheller (6.67), 3 farmers leased corn Sheller (10%), and 25 farmers did not own any corn Sheller (83.33%). The quality factor was categorized as nearly low. Therefore, in order to support the corn supply chain sustainability, the procurement of corn Sheller through self-funding in farmer groups as an organization should be proposed. The role of local government in funding the corn dryer and providing training in using the Sheller is necessary. From a theoretical implication perspective, this supported a study [16] that corn dryer is very important and affect positively the production quality of corn. Proportionally, it may imply that by using corn Sheller, the quality of produced corn could accelerate the efficiency of time, cost, energy and farmer's income distribution.

4. Conclusion

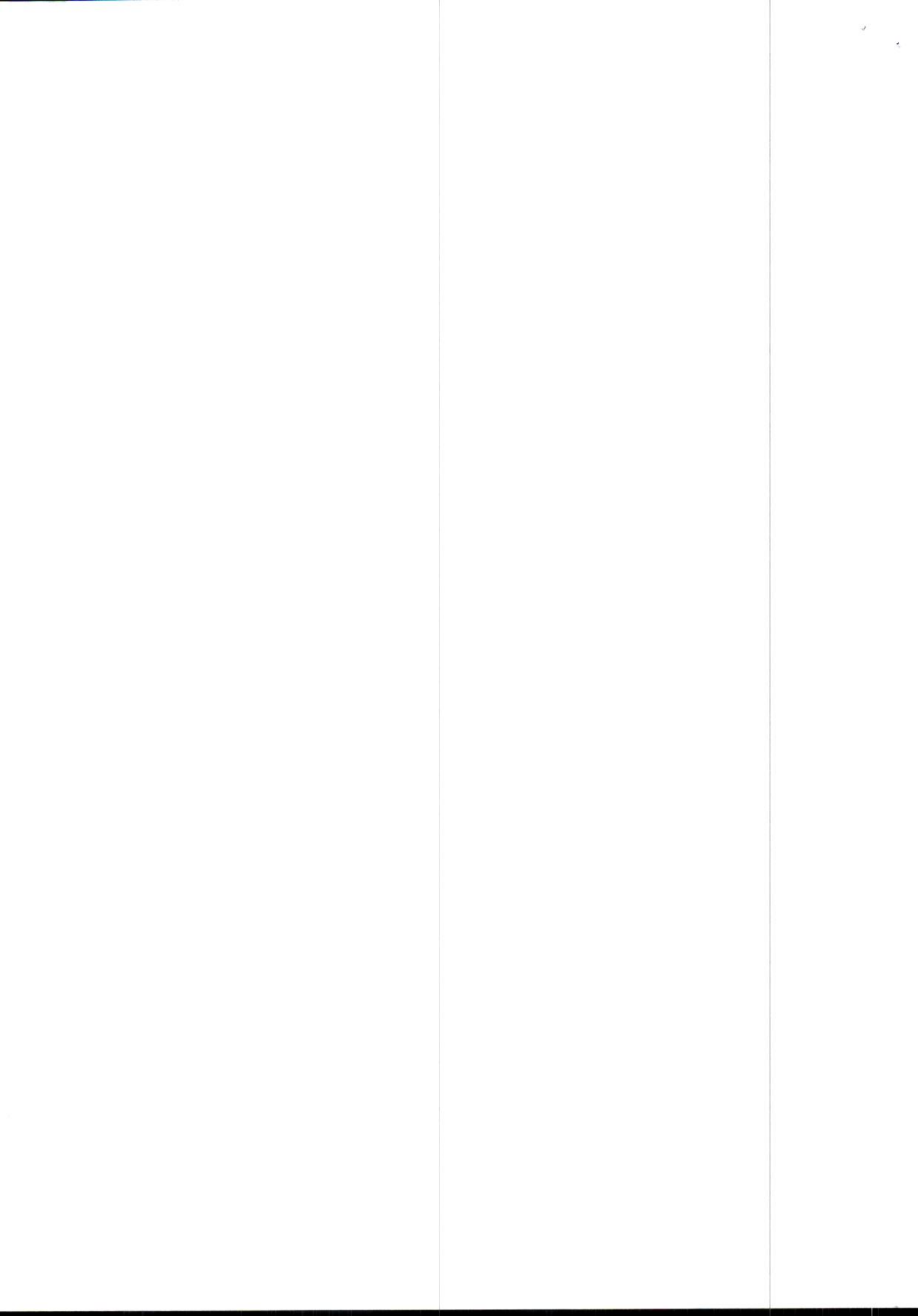
To ensure the sustainability of the supply chain of corn, the production factor for farmers should be strengthened including farmer's knowledge of farming method and market, sufficient capital for developing corn farming, sufficient land area. Therefore, strengthening farmer group is necessary. Corn Sheller and dryer should be provided to improve the efficiency and business opportunities will provide advantages to the corn farmer. Self-funding from the farmer themselves and the governmental role in providing extension, training, and procurement of corn dryer and Sheller through local government work unit regulated in the regional budgetary plan are also necessary.

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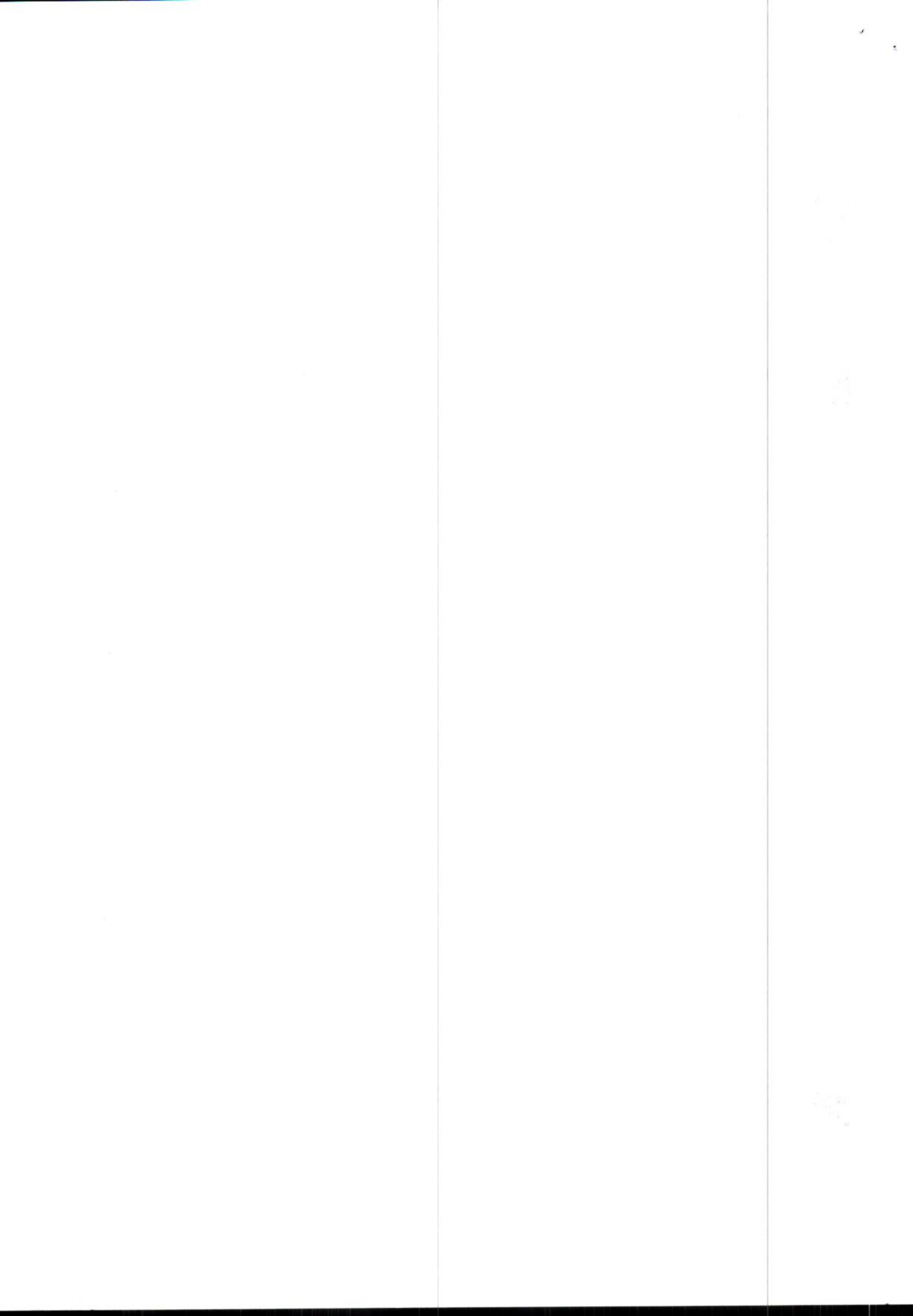
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