The Factors Influencing Fluid Fertilizer Use Intensity among Onion Farmers in Brebes District, Central Java, Indonesia

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Abstract: The behavior of the farmers to using the fertilizer could be influenced by some factors. The factors such as social environment, culture, agriculture differentiate the way of using intensity the fertilizer. That behavior can also be different to what fertilizer the farmers use. The study aims to identify and analyze the behavior of farmers in using intensity of the liquid fertilizer products. The research was conducted by using a survey approach through interviews and questions (questionnaire) to 100 respondents of onion farmers in Brebes District Central Java on April until May 2015. Factors affecting the using intensity were analyzed by using multiple linear regression analysis. As the result shows in this study show that the using intensity of the liquid fertilizer is influenced by the income, the experience in planting the onions, how large the land, the productivity of the onion, the cultivating season, the recommendations from other farmers, field trials, and recommendations from the fertilizer store. The implication of the study is the farmers behavior to using the fertilizer is not only influenced of rational factors but also influenced by psychosocial factors. Government efforts to educate farmers about the benefits and risks to using liquid fertilizer need involves both aspects.

Keywords: liquid fertilizer; using intensity; farmers behavior

1. Introduction

The district of Central Java Province is the central areas of the main onion production in Indonesia. District Brebes was the one of districts in Central Java province that has the largest total land cultivated for commodities shallots. District Brebes supplies about 75% of the needs of onion in Central Java province and 23% of the national onion. With a production of 267 500 tonnes in 2012, agriculture accounted for the GDP onion Brebes by 58% (BPS

Brebes, 2013). The Central of onion was spread in 11 Districts (from 17 districts) with a 100,000-harvested area of 600,000 hectares per year. With an average tenure of each farmer of about 0.25 hectares, there are about 100,000 landowners of their livelihood on red onions. Onion cultivation by farmers and including micro and small enterprises (MSEs).

Fertilizer is a basic requirement that sustain farming activities onion farmers. Model onion cultivation intensively to encourage farmers to apply fertilizer intensive. The development of technology and the active promotion undertaken by the marketer of liquid fertilizer have affected the interest of farmers in the use of liquid manure in addition to other types of fertilizers. Liquid fertilizers have advantages over powder fertilizers because it is easier to be absorbed plant (Walsh *et al.*, 2014). Liquid manure more evenly and there will be no build up of fertilizer concentration in one place. If there is excess capacity in the soil fertilizer plant is by it self will easily manage the absorption of the composition of fertilizer needed. Liquid fertilizer provides nitrogen and other mineral elements needed for plant growth, especially in the dry season and less access wetland irrigation. Liquid fertilizer is not only given to the roots, but also can be administered in the leaves of plants (Kandil *et al.*, 2013).

Behavior of farmers in the intensive use of fertilizers is not only influenced by environmental factors in agriculture, but also personal evnironment, social and cultural environment and the influence of marketers. The previous research (Akpan *et al.*, 2012; Zhou *et al.*, 2010; Assa *et al.,* 2010; Maiangwa *et al.*, 2007; Paudel *et al.*, 2009; Olangunju & Salimonu, 2010; Okoboi & Barungi, 2008) found that the characteristic of the farmers such as age, education, the economic status, and the capital access influence the percentage of the using fertilizer intensity whether it is for organic or synthetic fertilizer. The education in this case contributes to the farmer knowledge, the competency and skill in production or in managing the household economy (Okoboi & Barungi, 2008). The young farmers tend to be easy in adaptation toward the change, be responsive to get the information while the old farmers tend to keep the tradition (Zhou *et al.*, 2010); but according to Knower and Bradshaw (2007) said that the age of the farmers does not correlate with the behavior of the farmers. The farmers who are in enough economy status tend to be easy to purchase more fertilizer while the farmers with the low economic status tend to use the organic fertilizer from their own farm (Maiangwa *et al.,* 2007; Paudel *et al.,* 2009; Olagunju & Salimonu, 2010; Okoboi & Barungi, 2008).

The use of fertilizers by farmers can be influenced by agricultural land, access to irrigation, the cultivating season, the fertility of land, and the type of crops. The agricultural area nowadays can be characterized only from limited land area, the fertility decrease in agricultural land. The unpredicted weather and climate can affect farmers' behavior to use fertilizers. According to Valiarana and Saptana, (2010), the using of the fertilizers is naturally influenced by the acreage of agricultural commodities, the intensification level of farming represented by the fertilizer use, soil fertility, and the agro-climatic

conditions of the region. Farmers tend to have more experience to face the precipitation and temperature changes.

Climate change has a significant impact on agricultural sector and become a challenge to farmers in adaptation toward the land use and production changes (OECD, 2012; Darma *et al.*, 2014). The wider the area, the greater the need of fertilizer in production activities (Zhou *et al.*, 2010; Assa *et al.*, 2010; Zhou *et al.*, 2010; Maiangwa *et al.,* 2007; Ugwuja *et al.,* 2011). Kassie *et al.* (2009) found the factors in soil fertility determine the fertilizer amount needed by farmers. Farmers who have a good experience in deciding the types of fertilizer tend to use the same fertilizer which the farmers bought before production activities begin in the next period (Liu *et al.*, 2009, Ugwuja *et al.*, 2011). The fertilizer demand tends to increase in wet season because the use of the fertilizer will decrease in the dry season (Alpoko & Yiljeb, 2001). But it is different from the irrigated-agricultural areas which do not depend on the season (Akpan *et al.*, 2012; Assa *et al.*, 2010). It might be different for different types of fertilizer as well.

The behavior of farmers in fertilizer use intensity can also be influenced by the socio-cultural environment. Farmers can adopt the technology in agricultural production whether it is from formal or informal information (Savran *et al.*, 2010). Formal information sources are from elucidation or instruction program (Savran *et al.*, 2010). Besides giving the information, the extension worker can also take role as a marketing agent. Non-formal information sources are from family, group or neighbors, and from the media (Savran *et al.*, 2010). Farmers can easily be influenced by the neighbors who successfully manage their agricultural production by using certain types of fertilizer (Maiangwa *et al.*, 2007). Community farmers generally are difficult to use certain types of fertilizer in the long term and it is believed that it can increase the agricultural production (Olagunju & Salimonu, 2010). A farmer occupation is generally based on tradition, what they are used to do, and hereditary. It is difficult to face the changes for old farmers in community because they (especially the older generation) are still follow the tradition. Family members such as the children and the wives of farmers also involve in deciding to use the family income to purchase the fertilizers. The children and the wives of farmers share the income for consumption (household, education, health) or production (purchasing: fertilizers, seeds, pesticides, agricultural or livestock investment tool) in certain amount or a particular type of fertilizer.

Distributor can influence the preferences and attitudes of farmers through: product, price, distribution and promotion (Zhou *et al.*, 2010, Assa *et al.* 2010; Maiangwa *et al.*, 2007; Paudel *et al.*, 2009; Olagunju & Salimonu, 2010; Okoboi & Barungi), 2008). The quality of the fertilizer products can influence the farmers to use or switch to other fertilizer products. Besides the products, pricing and distribution, promotion by the marketers often affects the knowledge, perceptions and attitudes of farmers and local agricultural elucidation.

Generally, farmers using the intensity of liquid fertilizer as the leaves fertilizer to

make the plants greener. Those leaf fertilizers are used with other fertilizers. The nitrogen contained in liquid fertilizers tends to replace the nitrogen in nature to keep the plant green. There are several benefits in using the liquid fertilizer. Those are: 1) it is easy to dissolve or easy to absorb in the soil, 2) It can quickly overcome the nutrients and provide more nutrients, 3) It will easily to adjust the absorption composition of the fertilizers, 4) It will not create the buildup in the fertilizer concentration, 5) In addition, the liquid fertilizer can be used directly on the soil and did not take more time intervals. Liquid fertilizers are not only spread around the plant but it is also given above the leaves. Based on the explanation above, it is known that the behaviors of the farmers in using the intensity of fertilizer products are very complex and heterogeneous. It tends to be influenced by the outside agricultural environment factors. Fertilizer using the intensity behavior may also be different from one type of fertilizer to another. The study aims to determine and analyze the factors affecting in using the intensity of liquid fertilizers.

2. Materials and Method

This research was conducted by using survey approach through interviews with a list of questions (questionnaire) to 100 onion farmer respondents in Brebes Central Java in April to May 2015. There are 11 districts (out of 17 districts) with harvested area 20,000 - 25,000 hectares per year. Based on data from the Department of Agriculture, Food Crops and Horticulture in Brebes (CBS, 2013), the union centers are spread in the district of Bradford, Wanasari, Bulakamba, Tanjung, Sejong, Kersana, Ketanggungan, Larangan, Songgom, Jatibarang, and Banjarharjo. The variables in this study consisted of two variables, exogenous and endogenous variables. Exogenous variables consist of: Personal Characteristics of farmers, Characteristics of the agricultural environment, Social and Cultural Characteristics of the farmers and Marketers efforts. Endogenous variable is the decision of farmers in using the intensity of the fertilizer.

By using the analysis of linier regression, the influence of personal characteristics of farmers, agricultural environmental characteristics, social and cultural characteristics of farmers and marketers effort to distribute the liquid fertilizers is known. The model is demonstrated as follows:

$$Q = \alpha_0 + \alpha_1 Y + \alpha_2 AGE + \alpha_3 EDU + \alpha_4 EXP + \alpha_5 CAP + \alpha_6 LAND + \alpha_7 IRIG + \alpha_8 PROD + \alpha_{10} PL + \alpha_{11} KT + \alpha_{12} PP + \alpha_{13} TR + \alpha_{14} P + \alpha_{15} DIST + \alpha_{16} PROM1 + \alpha_{17} PROM2 + \alpha_{18} PROM3 + Z1$$

Where: Q= The total intensity used of fertilizer by the Farmers (liter), Y = income of the farmers (USD), AGE = the age of farmers (year), EDU = Education of farmers (ordinal), EXP = Experience of farmers (year), CAP = The access to capital (1 = no, 0 = no), LAND = total area (Ha), IRIG = access to irrigation (2 = technical, 1 = semi-technical, 0 = rain fed)), PROD = productivity of farming onions (kg / ha), PL = the recommendation from other farmers (3 = very often, 2 = often, 1 = never), KT = farmer groups (the meeting of farmer groups), PP = recommendation agricultural elucidation (3 = very often, 2 = often, 1 = never), TR = field trials of liquid fertilizer (1 = no, 0), P =

price of liquid fertilizer (3 = very important, 2 = important, 1 = not important), DIST = the ease to get liquid fertilizer (3 = very important, 2 = important, 1 = not important), PROM1 = rebate (1 = yes, 0 = no) PROM2 = recommendation from marketers (3 = very often, 2 = often, 1 = never), PROM3 = recommendation from clerk (3 = very often, 2 = often, 1 = never), α = intercept and slope. To assess the accuracy of the sample regression function in assessing the actual value can be measured from its *goodness of fit*. Statistically the *goodness of fit* can be measured from the statistical value of F and coefficient determination. The coefficient of determination (R^2) is used to determine the percentage of dependent variable change caused by the independent variable. F test is the significance testing of the equations used to determine how influence the independent variables on dependent variable (Y). The p-value is the probability of rejecting the null hypothesis given that it is true. The significance level is 1% (very significant), 5% (significant) and 10% (moderate significant). The p-value is less than the significance level, then an investigator may conclude that the observed effect actually reflects the characteristics of the population rather than just sampling error (Cowles & Davis, 1982).

3. Results and Discussion

The results of regression testing factors influencing the Liquid Fertilizer using the intensity presented in Table 1. The results of the regression equation demonstrate by the F-test of 20.046. Therefore the value ρ = 0.000 below 0.05. The model is fit and acceptable. It means that there is no different between the observed data with the model. The results of regression equation reaches R^2 values of 0.589 or 58.9% reflecting that all the independent variables are able to explain the variation changes which increase or decrease in dependent variable (total using the intensity of fertilizer) to 58.9%, while the other is, 41.1 % influenced by other variables that are not involved in this research model.

Table 1. The Result of the Regression Test Influencing the Fertilizer Used Intensity Factors

	B	t	p
(Constant)	1,700	0,789	0,427
1. Income	0,063	3,407	***)0,001
2. Age (year)	0,079	0,400	0,678
3. Education	0,241	1,101	0,271
4. Experience	0,431	1,926	*)0,057
5. Capital access	0,228	0,781	0,440
6. Land area	14,725	9,064	***)0,000
7. Irrigation system	-0,066	-0,360	0,708
8. The union productivity	0,096	1,833	*) 0,070
9. The other farmers	1,556	1,974	*)0,052
10. The farmers group	0,336	0,863	0,387
11. The extension worker	1,465	1,436	0,107
12. The field test program	1,678	2,184	***)0,009
13. Price	-0,406	-1,019	0,308
14. The ease to get the fertilizer	-0,459	-1,317	0,190
15. Discount	-0,191	-0,791	0,425
16. The distributor recommendation	-0,108	-0,493	0,613
17. The shop assistant recommendation	0,799	3,012	***) 0,003
R Square	0,577		
F-test	19,645		
Sig. F-test (p)	0,000		

Note: ***) level of significancy = 1%, **) level of significancy = 5%, *) level of significancy = 10%

Source: From questioner data, 2015

This research found 18 factors as the total and 9 factors significantly influence the liquid fertilizer using the intensity. These factors are the income, experience planting onions, land, irrigation systems, and onion productivity, the growing season, field trials, and recommendations from clerk. While 8 other factors did not significantly influence the liquid fertilizer using the intensity.

The income factor positively affects the liquid fertilizer using the intensity (p =

0.001 <5%), which shows the raising income and followed by the raising in liquid fertilizer used intensity. In the contrary, it shows the decrease in liquid fertilizer used intensity. It shows that, the regression coefficient (slope) ($\beta = 0.063$) means that the raising in farmers' income is on Rp 1 million and followed by the increasing number of liquid fertilizer using the intensity for 0.063 liters. In the contrary, farmers' income is decreased by 1 million USD will be followed by the decrease of the liquid fertilizers used intensity to 0.063 liters and the variables must be constant. The average liquid fertilizer used intensity in one year was 7.06 liters in the area of 0.47 hectares with an average income to 88.83 million. Farmers with higher incomes have more chance to used intensity more fertilizers while farmers with the low financial will reduce the fertilizer used intensity and change to the artificial fertilizers or replace it by using other organic fertilizers (Maiangwa *et al.*, 2007; Paudel *et al.*, 2009; Olagunju & Salimonu 2010; Okoboi & Barungi, 2008).

The result shows there is no significant finding for age and education. Age factor does not significantly influence the liquid fertilizer purchase ($p = 0.678 > 5\%$), which does not indicates the increase or decrease based on the in age. The finding of this research is different from Zhou *et al.* research (2010) who found that young farmers are generally more adaptable to face the change, responsive to the information while the old farmers tend to keep the tradition. The result of this study demonstrates the same as Knowler and Bradshaw (2007) research who found the age of the farmers do not show the significant relationship with the behavior. The insignificant education variable levels is caused by the same perception of the farmers (young and older generation) to increase the productivity by using fertilizer.

Education level factors do not significantly influence the use amount of liquid fertilizer ($p = 0.241 > 5\%$), which indicates an increase or decrease in the level of education not always accompanied by an increase or decrease in the amount of liquid fertilizer used intensity. The insignificant variable levels of education can be caused due to the complex role of education. On the one hand, higher levels of education can facilitate the use of fertilizers by providing access to information and knowledge about fertilizer. Better educated farmers increase the awareness of the benefits of the use of fertilizers to increase productivity and to determine the technical information needed to use them effectively. Therefore, they tend to use the right amount.

The experience factors positively effect on the amount of use of liquid fertilizer ($p = 0.057 <10\%$), which indicates an increase in the experience of farmers in agriculture will be followed by an increase in the amount of liquid fertilizer used intensity and conversely the decrease in the experience of farmers will be followed by a decrease in the amount of liquid fertilizer used intensity as well. The experience of farmers provides knowledge of the impact of using fertilizer to the costs and profits of onion production which are both respectively important factor for their decision in using of fertilizers. Farmers who have successful experience using of certain types of fertilizer will tend to use those types for production in the next period (Liu *et al.*,

2009, Ugwuja *et al.*, 2011). The effectiveness of fertilizer (fertilizer impact on production) is very important for around 93% of farmers. Effectiveness can be influenced by the dose of fertilizer and the applying methods of fertilizer usage in production process.

These things affect the growth of plants along with the weather, irrigation and farm management. Besides, the more successful experience of the farmers to buy a particular type of fertilizer and managed to increase their production, the more confidence will be possessed in using that product. Farmers who have gotten the experience of using certain fertilizer will diminish likely behavior of searching for information about alternative options for other fertilizer products. Changes in the use of fertilizer products will lead to risk because the consequences of these changes are unpredictable. In the case of the constancy of other variables, the regression coefficient (slope) (β = 0.431) means that the increase in experience of 1 scale will be followed by an increasing number of liquid fertilizer used intensity for 0,431 liters and conversely the decline of experience of 1 year, will be followed by a decrease in the amount of the purchase of liquid fertilizer for 0,431 liters.

The capital access factor does not significantly influence the se amount of liquid fertilizer (p = 0.440> 5%) which indicates an increase or decrease in the ease of obtaining capital in farming is not always accompanied by an increase or decrease in the amount of liquid fertilizer used intensity. Capital will enhance the ability of farmers to buy fertilizer but it has no significant effect. This can be caused by the use intensity of liquid fertilizers that does not require huge capital.

The land area factors positively affects the use amount of liquid fertilizer (p = 0,000 <1%) which shows an increase in land area will be followed by an increase in the amount of liquid fertilizer used intensity and conversely decrease in land area will be followed by a decrease in the amount of liquid fertilizer used intensity. In the case of the constancy of other variables, the regression coefficient (slope) (β = 14.725) means that the increase in the extent of land area amounted to 1 ha will be followed by an increasing used intensity of liquid fertilizer for 14.725 liters and conversely decrease in the extent of land area amounted to 1 ha will be followed by a decrease in the amount of fertilizer amounted to 14.725 liters of liquid. The extent of land area increases the scale of farming. Large scale requires more input from suppliers, including the use of fertilizers in increasing agricultural production (Zhou *et al.*, 2010; Assa *et al.*, 2010; Zhou *et al.*, 2010; Maiangwa *et al.,* 2007; Ugwuja *et al.,* 2011; Samad, 2014).

Factors of irrigation system do not significantly influence the using intensity of liquid fertilizer (p = 0.722> 5%). Firslty, this is due to the need for liquid fertilizer in the semi-technical irrigation system is higher than the needed amount of fertilizer in technical irrigation systems. This happens because in technical irrigation systems, irrigation is done naturally by flowing water from the reservoir to the water channels, while the semi-technical irrigation system watering is done through pumping of groundwater. This causes nutrients in the technical irrigation system is higher

than nutrients in semi-technical irrigation systems, so the need for liquid fertilizer in the semi-technical irrigation system was higher than in technical irrigation systems. Secondly, the needed liquid fertilizer in semi-technical irrigation system was higher than in rainfed farming. Irrigation system which allows the plant to absorb more fertilizers motivated farmers to apply larger quantities. Land connected to the irrigation networks are usually flat, easily accessible and have the results greatly safer in various conditions of rainfall so that farmers face a lower risk in applying more intensive fertilizing (Akpoko & Yiljeb, 2001, Akpan *et al.,* 2012; Assa *et al.*, 2010).

Onion productivity factor positively affects the using intensity of liquid fertilizer ($p = 0.070 < 10\%$) which indicates an increase in the productivity of onion will be followed by an increase in the amount of liquid fertilizer used intensity and conversely a decrease in productivity of onion will be followed by the decrease in the using intensity of liquid fertilizer. Farmers, who prioritize increased productivity of onion, tend to apply more fertilizer intensively. The use of fertilizers in the cultivation of onion will affect production and ultimately affects the income of farmers. Fertilization is done to add nutrients to the plant. Fertile soil and sufficient nutrients will affect the production and the growth of plants. Not all the nutrients contained in the soil can be absorbed by plants, therefore the cultivation is needed to make sure the nutrients absorbed easily by the plants. However, in terms of the regression coefficient, the influence of onion productivity on the using intensity of liquid fertilizer is low at under 10%. In the case of the constancy of other variables, the regression coefficient (slope) ($\beta = 0.096$) means that the increase in productivity of onion for 1 ton / ha will be followed by an increase in the using intensity of liquid fertilizer for 0,096 liters and conversely a decrease in productivity of onion for 1 ton / ha will be followed by a decrease in the amount of purchases for 0,096 liters of liquid fertilizer.

Other farmers recommendation factors positively affects the using intensity of liquid fertilizer ($p = 0.052 > 5\%$ but $<10\%$). The regression coefficient (slope) ($\beta = 1.556$), shows that the increase on other farmers by a unit will increase the amount of liquid fertilizer using intensity for 1,556 liter, in the case of the constancy of other variables.

The farmer social gathering does not significantly influence the amount of liquid fertilizer used intensity ($p = 0.387 > 5\%$). Insignificant influence can be caused by the absence of recommendation of other farmers or the incapability of extension worker in suggesting an increase the amount of liquid fertilizer used intensity.

Extension worker factor positively does not affect the used intensity of liquid fertilizer ($p = 0.107 < 5\%$). In the case of the constancy of other variables, the regression coefficient (slope) ($\beta = 1.465$).

Field trial factor positively affects the using intensity of liquid fertilizer ($p = 0.009 <1\%$) which indicates that farmers who buy most of the of liquid fertilizer products have seen a field trial. The regression coefficient (slope) ($\beta = 1.678$) means that a farmer who has seen a field trial has 1,678 liter higher than farmers who have never seen a field

trial, in the case of the constancy of other variable. Field trials factor reduces the time and risk for the use of new products. The success of field trials will increase the confidence of farmers to use of new fertilizer products.

The price factor does not significantly influence the amount of liquid fertilizer used intensity ($p = 0.308 > 5\%$), which indicates an increase or decrease in the price of liquid fertilizer is not always accompanied by an increase or decrease in the amount of liquid fertilizer used intensity. Price affect the cost needed by farmers to spend on the using intensity of fertilizer, but the price does not have a significant effect because farmers will apply the right amount of fertilizer to increase production regardless the increase / decrease in price. The availability of fertilizers is important to secure the harvest. Although price factor is important to consider by farmers in the purchase of fertilizers, but it becomes less important if farmers have entered the time of fertilization. They believe that late fertilizing will affect productivity. So if the time of fertilization comes, the farmers will surely buy fertilizer even though the price is quite expensive.

The ease factor of obtaining liquid fertilizer product does not significantly influence the amount of liquid fertilizer used intensity ($p = 0.190 > 5\%$), which indicates an increase or decrease in the ease of obtaining liquid fertilizer products is not always followed by an increase or decrease in the amount of liquid fertilizer used intensity. The discount factors does not significantly affect to the purchase of the liquid fertilizers ($p= 0.190 > 5\%$) which shows whether the discount exist or not does not follow with the increase or decrease of the fertilizer.

Marketers recommendation factors does not significantly influence the useing intensity of liquid fertilizer ($p = 0.613 > 5\%$). This shows marketer's recommendation is not effective to increase the amount of liquid fertilizer used intensity.

Recommendation of shop assistant factors positively affects the used intensity of liquid fertilizer ($p = 0{,}003 <1\%$), which shows the more shop assistants recommend, the more amount of liquid fertilizer will be purchased and conversely the rare recommendations by a shop assistants will be followed by a decrease in the amount of liquid fertilizer used intensity. The regression coefficient (slope) ($\beta = 0.799$) means that an increase in recommendation of shop assistant for 1 unit will be followed by an increase in the amount of purchases of liquid fertilizer for 0.799 liters and conversely the decrease in shop assistants recommendations for 1 unit will be followed by decrease in the number of purchases amounted to 0.799 liters liquid fertilizer, in the case of contancy of other variables.

4. Conclusion

The liquid fertilizer used intensity is influenced by income, experience of planting onions, land area, the productivity of onion, recommendations of other farmers, information of extension worker, field trials, and recommendations of shop assistants. The higher income and the wider land area are followed by an increase in the amount of liquid fertilizer use. Farmers who gain experience and success in using specific fertil-

izer products will increase motivation farmers to apply larger quantities. Farmers who prioritize an increase in the productivity of onion tend to apply a liquid fertilizer more intensively. The experience of other farmers, information of extension worker, success of field trials, recommendations of shop assistants, increases the number of used intensity.

This study may provide different results if applied in conditions of physical and social environments of different agriculture. Therefore, further research can do research in other areas with different social and physical environmental conditions and different peasant economy. Both studies are conducted by a survey and analysis of the determinants approach in order to provide limitations to include the variable of time, for example relating to the supply of, demand for fertilizer, and the price along with substitute products from time to time. These factors may be factors that can affect the amount of fertilizer use.

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