



Full Length Research Paper

Common pitfalls in use of chemical fertilizer: opportunities vis-à-vis challenges of chemical fertilizer application in agriculture. District of Anna Sorra in Oromia regional State, Southern Ethiopia

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Abstract

Declining of soil fertility is recognized as major bio-physical constraints affecting agricultural production in Ethiopia. The struggle for food security is the main concerns of the population of the country. The objective of the study is to assess challenges and opportunities of chemical fertilizer use in Ethiopian agriculture. Both primary and secondary data sources were used to conduct the research work. Interview, FGD and personal observations were tools used to obtain primary data. And as source to secondary data, different published and un-published materials were used. Purposive sampling techniques were used to identify the respective kebeles of study. Simple random sampling was applied to identify farmers. By the proper sample allocation of Cothari 2004, 212 house hold selected from each kebeles. The farmer inclusion in agricultural research is limited and giving decision-making power to farmers has not been promoted. About (52%) of them commit non reversible technical mistakes during fertilizer application. Extension program delivery and farmer participation remain very low. Those farmers have good access to information and training, are better in applying chemical fertilizer.

Keywords: Food security, sustainable agriculture, Chemical Fertilizer, Nutrient depletion

INTRODUCTION

Much number of world populations is in solid need of food self-sufficiency. For so long time and yet, the struggle for food security is one of the main concerns in many developing countries. It remains much more challenging tackling the negative association between food demand and supply from agriculture. Sustainability in agriculture and livelihood improvement in developing countries is obliged to be more of theoretical than practically achieved. In many developing countries, nutrient depletion already threatened food production, so that food shortage in Africa is a serious problem (NEPAD, 2007). Most of Sub Saharan African (SSA) countries including Ethiopia are remained highly food in secured. As tried to be generalized from different sources, agricultural un-sustainability can goes to many in number and diversified reasons. Low agricultural productivity can be attributed to limited access of small scale farmers to

agricultural inputs, technologies, irrigation and more significantly to poor land management activities that have led to continuous nutrient depletion from farm land (Mekuria 2014). According to (Yohannes 2004 cited in Mekuria 2014, food insecurity and land degradation have become chronic problems in Ethiopia. Ethiopia is one of the country with highest rates of nutrient depletion in SSA that the annual Phosphorus and Nitrogen loss nationwide from the use of dung for fuel is equivalent to the total amount of commercial fertilizer applied (MoA, 2009). Therefore, it has leaded the highest estimated rates of soil nutrient depletion which reduces productivity and increases vulnerability to food insecurity. There are many factors responsible for soil nutrient depletion. It might be attributed partly to the failure to take substantial care to the soil resources while remaining unaware of the tragic consequences. Ethiopia have potential agricultural

resource base, most of the population remained food insecure for number of decades. Agricultural sector has failed to meet its population immediate need for food. According to Yohannes (2004), failures in agricultural productivity has been attributed to a wide range and combination of factors, such as population pressure, backward traditional farming, ignorance and reluctance of farmers to adopt modern technology, in appropriate agricultural policy, absence of land insecurity, inadequate marketing systems and transfer of in appropriate technologies.

Beyond that, agricultural activity of the country has been facing numerous agronomic problems including continuous soil fertility loss, increasing weed problems, widespread infestation of pests, accelerated erosion, recurrent and widespread drought periods that treating millions of Ethiopians.

Agricultural extension services in Ethiopia have tended to be top-down and focused on technology transfer approaches (Teklu and Gezahegn, 2000). This type of agricultural strategy will no longer last in achieving in boosting agricultural productivity. There is mismatch between agricultural policy made at central government and prability of the policy on farm land. Technology adoption and transfer approach is without reasons remain top-down and applied almost excluding practical problems and challenges on farm land, farmer's educational and economic level. In most circumstances, recommended agricultural strategy neglect not only farmer's rural livelihoods and the bio-physical (soils, climate, ecology...) fundamental agricultural output determinants, socio-economic diversities at local level, but also practical discovery, recommendation and experience of development agents. There is a practical work of empowering farmers, which include assigning development agents (DAs) at each kebeles (rural small unit of district) to help farmers gain training at farmers training center (FTC), demonstrate farm land preparation and proper fertilizer application and seed dispersal. However, there is only small and lethargic change in production, where numbers of the farmers are not yet food secured.

Therefore, as part to this paper work, it is an attempt made to find out that, pitfalls in chemical fertilizer distribution, technical and practical constraints related to efficient and sustainable fertilizer use on farm land, and economic tragedy of chemical fertilizer use in rural Ethiopia. It's also an attempt to assess tangible productivity change in hand to mouth agriculture on very limited size of cultivable land.

Objective of the Study

General Objective of the Study

The general objective of the study is to assess challenges and opportunities of chemical fertilizer

use in rural agriculture.

Specific Objectives

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- To assess the relationship between modes of access to land and soil fertility management practices
- To identify leading challenges of chemical fertilizer application and its effect on agricultural productivity on farm land.
- To analyze attitudinal and skill change of farmers post-extension and training in chemical fertilizer application.

Research questions

- What kind of relationship is there between modes of access to land and soil fertility management practices?
- What are leading challenges of chemical fertilizer application and its effect on agricultural productivity on farm land?
- What attitudinal and skill relationship is there in farmers post-extension and training in chemical fertilizer application.

RESEARCH METHODOLOGY

Description of the study site

Anna Sorra is one of the Woreda found in Guji zone of Oromia Regional State. And the zone is named after a tribe of the Oromo people 'Guji'. It had been a part of Borena zone until it along with four other Woreda were split off in September 2003 to form the Guji zone. It is bordered on the south by Borena Zone, on the west by SNNPR Regional state, on the north by the Ghenale River which separate it from Bale and on the east by the Somali region. Astronomically, the district situated at 6⁰15'N to 7⁰N and 38⁰45'E to 39⁰15'E north of the equator.

The woreda has diverse topographic features that led it experience a complex and diverse climatic condition. The woreda have diverse agro-ecological zone which is direct cause of experiencing complex climatic condition. And attitudinally, it district ranges from 1200-2800 meter above sea level.

The district encompasses Kola, Dega and Woina dega agro-ecological zones. It receives an estimated amount of 350-1830mm of rainfall annually and with annual average temperature of 11.2-21⁰c, Anna sorra district agricultural office (ASDAO). The district has two main rainy seasons, spring and autumn that are locally known as *Ganna* and *Hagayya* rains respectively. Most of the area receives its maximum rainfall in spring and small rainfall in autumn. Expected to be 78 % of the of the total annual rain fall is received during spring season which comes at the end of February to the May and autumn is

the minor rainy season of the area where rains begins in September and ends in November.

There is no detailed study woreda's soil type and distribution. However, agricultural agents and the agricultural development office of the district indicated the soil type of the area is mainly Nitosols and Acrisols. In addition, according to ASDAO the soil of the study area are classified as black, red and brown soil accounting 06.19%, 41.31% and 52.50% respectively (ASDAO). Barley, Wheat, Corn (maize), Teff, Horse been and Pea are important crops cultivated. And *Enset* remain staple food, where coffee is grown in some parts of the district.

Sources and Method of Data Collection

Both primary and secondary data sources were used to conduct the research work. Primary data were collected through Questionnaires, Key informant interview, Focus group discussion and personal observation.

Questionnaire: Structured questionnaires were developed and necessary information was gathered from the farmers. Questionnaires are mainly interested in gathering information concerning the overall challenges of chemical fertilizer application on farm land, practical strength and weaknesses of applying chemical fertilizer, extent and factors affecting pattern of fertilizer use per household. Questionnaires was first developed in English and later translated in to vernacular language of the farmers. Four enumerators whom completed first university degree was selected and trained how to disseminate and collect the information from the farmers. The researcher facilitated, checked and maintained the progress.

Focus Group Discussion (FGD): The researcher has used FGD to sum up and yet to compare responses given by the farmers and what are there on field. Few selected model farmers, agricultural agents and district agricultural office experts was included. It was done to come up with district agricultural activity, challenges, benefits and limitations of using chemical fertilizer. Its value was more important than what I can verbally disclose. I found it was worthwhile, especially investigating the challenge in using fertilizer on farm land and the very discouraging pattern of condition in application of chemical fertilizer on subsistence farming.

Observation: Direct observation was done to and farmer's practices on farm land how and when they apply the fertilizer. It was mainly an attempt made to search for farm land preparation, when and how chemical fertilizer is applied on farm land.

Secondary data were obtained from published and unpublished materials that have direct or related relevance to the study.

Study Design and Target population

The research was a case study research design. The

target population of the study was house hold (farmers) of the four kebeles namely, Gosa Hellu, Woma Shella and Melka Dimtu and Kalle Kuku in Anna sorra district of Guji zone, Southern Ethiopia.

Sampling procedures and sample size determination.

The study was conducted during the early 2012 to late 2013 farming seasons of the study area. Firstly, four rural districts (*kebeles*) involved in the study were obtained from the district by purposive sampling procedure. It was reasonably there, there is potential agricultural land, and expected to be potential areas of the district that use chemical fertilizer in agriculture targeted food crop production, but failed to feed each house hold in particular and study area in general. Though it was long time I left to live in the area under study, but being the researcher that came out of that local area, I know living condition of the population of the area and agricultural activities too to the most. Food insecurity is the most challenging economic problem knocking the door of each house hold. From theoretical point of view and yet many scientific recommendations assures application of chemical fertilizer boost agricultural productivity. But I was been impressed of the failures or the tragedy of gaining farm land productivity lesser and lesser as time goes. Yearly, on farm productivity is going down and down with time progress. Thus, assessing the problems behind this complexity remained number one focus of this paper work. As a result, the innermost interest of the researcher is to find out what was been the challenges and tragedy behind their subsistence farming that let them not to ensure food security. From then on, out of total 2122 households of the four kebeles, 212 household headed farmers which will count to be 10%, were selected through simple random sampling procedure by the help of Kothari (2004) proportional sample allocation formula. Accordingly, from 580, 600, 540 and 400 farmers' house hold, 58, 60, 54 and 40 representative house hold were randomly selected from Gosa Hellu, Woma Shella, Melka Dimtu and Kalle Kuku respectively. Therefore, the head of households was incorporated in the study as the target population. Researcher used proportional sample allocation procedure of Kothari (2004). Thus, representative sample of this study were computed by the formula: $nh = \frac{Nh}{N}n$, where: nh = sampling size of the study, Nh = Total population of the kebele, N = Total population (total hhs) and n = Total sample size

Method of Data Analysis

The analyses of the obtained data were done both quantitatively and qualitatively. Thus, responses to the questionnaires that was gathered from respondents was quantitatively analyzed which was assisted by Statistical Package for Social Science version 20.0 (SPSS) and

presented in percentages, frequency counts and simple cross tabulation, that the generalization derived of. Whereas, data gathered through observation and interview was qualitatively analyzed and presented descriptively.

RESULTS AND DISCUSSION

The source livelihoods of the farmers in the study area are mostly dependent on agriculture. About 86.9% of the farmers are engaged in mixed agriculture (crop production and rearing of animals). And only about 7.1% and 6% of the farmers solely engaged in crop production and animal rearing respectively. Animal rearing is source of income and practiced mainly to sustain families livelihoods in the case of crop fail.

The value of rearing animals is beyond a single factor. A number of respondents assert that dung collected from the cattle grazing area, serve as fertilizer to grow crops (manure), and the newly dropped dung serve as house decorating material and celebration of other cultural festivals. Moreover, in addition to use of cows for dairy product, they sell their cows to pay money for marriage as to reimburse the families of the girl (*qarshii araaraa*). It is cultural activity done just a days range from few weeks to 1-2 month after marriage. Appreciably, the family of boy has to pay money as compensation to the families of the girl that. Accordingly, about 4000-10,000 of the money is given to the father and 1000-4000 sometimes more given to mother of the girl. The amount of money varies from one area to another or depending on the educational level of the girl, social strata of both families or livelihood status of the girl's family. Thus, the high the educational level of the girl tend to raise the amount of money to be paid. Therefore, animals are sold to fulfill both home necessities and serve as an asset for such a social affairs.

Modes of access to land and soil fertility management relation

Farmers acquired their land through different means of access to land. Majority of the farmers acquired their land through inheritance making it the most common land holding system. About 90.8% households gained their own farm land either they inherited directly from their family or given by elders. Of this 90.8%, about 79.58% of the house hold inherited their farm land from their parents either for one or other reason. Inheritance reasonably varies. It might be if the family of the boy gives the land as the share of the property. And in another case, inheritance might be when the family of the boy died accidentally, then the elders come together and decide the share which will go to the individuals among the family. There are little percentages of access to land by rent and share that comprise 3.5% and 5.7% respectively

are the other mechanisms of access to land. The remaining 2.02% is access to land through contract. In inheritance way of access to land holding system, land given to the son either when the son form their own household after marriage or up on the death of parents given as share by the power of the elders of close relatives (Mekuria 2012). As most *Guji* people bear numerous amount of child, owing land at old age become lesser and lesser. Therefore, those who have more sons have tends to possess very small or no plots of land. In *Guji*, girls have no right to access to land as legal and formal as the boys do. Both in culture and norm, *Guji* community used to believe it is not logical and culturally sound that female can inherit the family's property unless the aged family not have boy. According to (Mekuria 2014), they believe females gain their own land from the side of her husband after marriage. This is true that a woman had their share (land, cows, sheep and all other resources) just next day after her marriage.

Ways of access to land determine possibility and degree of maintaining soil fertility on farm land. Soil fertility of land under rental or share cropping, will not at fullest paid due attention as that of inherited one. Better care of the land resource and higher degree of maintaining soil fertility sustainably is stronger in inherited land. This is because, farmer or the owner feels the land is his/her and only remain his/her property for ever. However, land in rental and share cropping season will only given conservation inputs that will not longer than farming season and term of cultivation. And (Mekuria 2014) better explained that, in share form of access to land, all the situation of production depends on the agreement of the two or rarely dominated by land owner if he put pre conditions like (type of crop to be cultivated, use of fertilizer, cost of labor and weeding) thus share cropper must abide, which this in turn cause the probability of maintaining soil fertility for long term less. Therefore, the possibility of soil fertility management explicitly reflects the interest and potential of holding land for long time for production. Thus, sustainability of farm land management and maintaining soil fertility decreases as the time to hold land decrease.

Tools used for land tillage

About 64% of the farmers use primitive way of land tillage which is either oxen-manual drawn or operating manually by prepared of metal and wood (*gottoo*). *Guji* people for a long and have been using pair of oxen (*Ximmaadii*) to till their land. Few of the farmers, those who lack pair of oxen, will search for the house hold which lack pair oxen and become together to make another pair, and will make tillage bit easier. Sometimes, groups of the farmers (*garee*) mainly consisting of about 5 member, or *kora* numerous in number, and *gootalee* which its number depends on farm land to be plough, frequency of work per week and other conditions) communally join one's

farm land and till down large amount of farm land in fraction of hours and turn green area into brown. This kind of farming practice relatively good in time managing, timely land preparation and proper cultivation of crop land as compared individually (personally) hoe based operated land tillage. Those farmers whom are working being in group, land preparation, and overall improvement of agricultural production is at ease.

Challenges of chemical fertilizer application

Farmers are not passive observers of what happening to their farm land. About 70% of farmers have experience of identifying declining of fertility of their farm land. At local level, it has become increasingly evident that farmers who are living under high risk and uncertainty have without any external intervention developed pools of indigenous practices which are gradually adapted to the environmental changes (Yohannes 2004). Here I am not sure enough to say farmers are perfect in analysing degree of fertility loss and mineral type that their soil lack, but they somehow do have their own means of identifying fertility of local soil on their farm land by simply identifiable parameters like colour, year left not tilled and texture of the soil.

Being in tragedy of food insecurity for long time, by the free will of government, farmers themselves and little to the Development Agents (DAs), farmers are being started to search for long lasting solution that help them maintain fertility of their farm land for the past ten years. With no doubt, possibility of producing optimum production is application of fertilizer on farm land. Urea and DAP is most commonly applied fertilizer. About 87% of farmers use DAP (Di-Ammonium Phosphate) and Urea while the remaining 13% of the farmers use indigenous methods of soil fertility management. However, there are a number of technical and physical challenges of properly applying chemical fertilizer. For instance, among total farmers that said to be fertilizer users on farm land majority (52%) of them commit non reversible technical mistakes during application. Firstly, innumerable portion of the farmers make technical mistake. This is the problem when farmers wrongly add chemical fertilizer on wrong soil type. Farmers add chemical fertilizer on soil without proper test of what fertilizer type is lacking. This is the most commonly seen challenges for nothing but extravagantly losing money for fertilizer purchase. Almost all fertilizer content of soil on farmers' farm land was not tested. None of farmers replied they have identified type of nutrient lacking from their farm land. Government and even DAs whom are assigned to rural kebeles are not practically included and priority do soil fertility test and recommend type of fertilizer to be applied on farm land. However, they commonly and in mass give extension to the farmers to use chemical fertilizer blindly on plot of land they owe. Zimmer et al, (2010) assures this will

cause problem when, applying a fertilizer that is too soluble or too insoluble for the soil condition. A good example is calcium. They disclosed, any farmers overdo lime on soil with a neutral or high pH where not very much of that lime will become available to plants. Another problem they continuously commit is when farmers apply a fertilizer that is not balanced, so there is too much of some nutrients and not enough of others. Consequently, this kind of unqualified recommended types of chemical fertilizer neither help the farmers to gain optimum product per farm land nor help boosting fertility of soil on farm land.

Secondly, the worst, farmers do not use proper type and amount of fertilizer that each item of plant need. From the survey made, there are farmers that use Urea for soil that leguminous plant roped over, which is misleading for the leguminous plants themselves fix nitrogen. The other commonly observed but remain most leading challenges was, when farmers apply fertilizer on farm land lesser to what agricultural expert recommend (specific to Ethiopia) per farm plot. In Ethiopia, holistically, MoA recommend DAP 100kg/ha and Urea 50kg/ha. However, being poor and remaining less trained, farmers share those recommended amount of chemical fertilizer among 4-5 and dispersing it on farm land which count to be only 25% of the recommended 100 percent. Therefore, trying to average whole farm field regardless of proper recognition of amount actually lack will value zero.

Thirdly, they don't know exact time of fertilizer application. Few of the farmers apply during seed dispersal while others together disperse while they plant seed, yet apply earlier or late of the normal that help proper crop growth. Zimmer et al (2010) claim a common mistake in timing is applying nitrogen in the fall when there isn't a growing crop there to capture that nitrogen. The fourth challenge is beyond technical failures, delay in fertilizer provision. There is usual delay in provision of chemical fertilizer; either it sometimes reaches the area early or late of cropping season. It is due to inaccessibility of the districts or infrastructural and facility problems. Sometimes the delivery remains much let and farmers remain without applying the fertilizer. And portion of the farmers whom are practically use fertilizer they stored carelessly year before are countless. Fertilizer sometimes fails to reach and distributed to the farmers on time. The main problem of soil nutrient decline is due to insufficient inputs applied to compensate for soil nutrient loss during farming season. Thus, the uses of chemical fertilizer at the study area are not promising in maintaining soil fertility at study area.

Attitudinal and skill change post access to extension and training

Low agricultural productivity is not something only

attributed to limited nutrient input and biophysical constraint but also limited access to information and extension (Michael 2002). The farmer participation in agricultural research and extension is limited. Moreover, concept of giving decision-making power to farmers has not developed and been promoted. As it tried to be mentioned, concerning the condition of fertilizer application on the farm land, there are complex and diverse determinants of amount and type of chemical fertilizer use. The month of June-August are the rush months where almost all farmers prepare and disperse seeds. Prior to the farming season, on farm land training was partially at few districts and completely absent to the other. To some extent at each *kebele*, farmers training center (FTC) was organized. Government intention of organizing FTC at each *kebele* was to demonstrate strong commitment to agriculture to enhance the delivery of improved production. Procedurally, there is deploying four DAs to work closely with farmers with responsibility for crop production, natural resource management (NaRM) and livestock production. However, the quality of delivery of these extension programs depends on the size of the rural *kebele* and population number to be served with the program. The larger the size of *kebele* and population, the lesser the frequency of access to information and training offered. For instance, *Kale Kuku* and *Melka Dimtu* is relatively vast in catchment area and population density and hence, remain the rural *kebeles* that experienced lowest rate of farmers training and extension program at FTC. *Gosa Hellu* and *Woma Shella* are the *kebeles* with lesser number of populations that obliged to be train inhabitant farmers count to be 72% before and during farming season, which is double of that of the *Melka Dimtu* 35%. As tried to capture information from DAs, it was not only population size and size of the *kebele* that hinder effectiveness of training to be offered, but farmers educational level. The higher the educational level the better the farmers follow and properly apply fertilizer and vice versa. In another case, *Melka Dimtu* is the rural *kebele* where majority of the farmers are not avail at training ground, for they engaged in digging gold mining that found at each and every corner of the *kebele*, mainly *Hobone*. *Hobone* is the common gold field where young boys and girls, old man and women come together to dig out gold, that the practice is locally known as (*Bosexo or Shofa*). Each and every one of the gentlemen joining *Hobone* daily will collect the money as good as they are lucky enough. Young boys, girls, men and women fill pity if not go to *Hobone* daily. One of the young boy named Genale from *Melka dimtu*, said "*Hobone haadha namaa Hobone oolu hamaan*" which literary mean *Hobone is mother of all and difficult to spend a day not seeing her*. Much percent of the money they gain daily as a wage from womb of *Hobone* not go more than filling the stomach of the young boys and girls, where they enter to small meat soup hat (*Gosee shorbaa*) and enjoy their dinner. Due to this and other

reason, there is lack of adequate and organized trainings for farmers. Thus, delivery of proper extension and DA-farmer linkage is very diminutive at *Melka Dimtu*.

Unlike to *Melka Dimtu*, things remaining inverse to the other *kebeles* like *Gosa Hellu* and *Woma Shella* where farmers claim they cannot attain training regularly. It is due to DAs themselves will not regularly organize training and delivery of extension works at FTC which help them they can benefit of the program. They disclose that, most of the professionals spend most of the days to the nearest town of *Bore* and *Irba Muda*. Thus, they attend intermittently organized training not in a frequency of more than 2-3 a month. DAs avail to the respective *kebeles* only when supervisors send notice they will come on orally notified day.

Similarly, at an average, the DA extension program and farmer linkage uncertainly remain very low for there is no close examination and control over the work efficiency of the DAs from the top management of agricultural office of the Woreda. Supervisors themselves they are tied with other bulky duties at administration level (fertilizer delivery process, workshops, and meetings) during the farming season (Mekuria 2014). Therefore, there is negative and insignificant relationship between access of farmers to training and application of DAs demonstration on the farm land in the study area.

To see the overall situation of the four *kebeles*' it is about 64.32% of the farmers that had contact with DAs though it was infrequent and at intermittent in time of training provision. Keeping all the factors constant, they learnt to some extent a number of packages on that occasion which lack repeated practices and demonstration. This kind of on and off type of training provision let them forget what they learnt a number of months before. Being challenged by infrequently and un-programmed training and demonstration, 22% of farmers disclosed they began to exit of the program (training at FTC).

However, those farmers that personally have good relationship with DAs and agricultural experts from Woreda and continually contacting them by any means they found, became profitable. They are better performers in multiple on field activities like soil conservation, technical use of fertilizer, animal husbandry, and sustainable farm practices. They are good in perceiving newly adopted mechanisms of soil fertility management than the time they were not attending the training offered at FTC and on farm land. Farmers whom are said to be model at each rural *kebeles* are those who had better attend training somehow, and developed skills in preparing their farm land, employing mechanized cultivation and on time dispersal of the seed which help them harvest good yield at the end of the day.

Therefore it can be generalized that, those farmers have good access to information, training and extension, are better in applying chemical fertilizer, properly prepare

their farm land and harvest optimum amount of crops yearly.

CONCLUSION

Similar to the other parts of Ethiopia, the livelihood of the farmers in study area is totally dependent on subsistent agriculture that includes rearing of livestock and cultivation of crops. Ways of access to land determine possibility and degree of maintaining soil fertility on farm land. Even though farmers are now become more familiar in using chemical fertilizer, the extent and amount of fertilizer used in a farm plot is significantly far less than what MoA recommend. Other challenge in fertilizer application is when farmers add chemical fertilizer on soil without proper test of what fertilizer type is lacking. Soil nutrient decline is due to insufficient inputs applied to compensate for soil nutrient loss during farming season is much lesser and lesser. Due combined farmers personal problems and infrequent training provision and technical support and demonstration, there are commonly observed challenges in chemical fertilizer application. The quest of when to apply, on what type of soil to apply, how to till farm land and amount of chemical fertilizer to be added predominantly an area that need intensive follow up. Those farmers have good access to information, training and extension, are better in applying chemical fertilizer, properly prepare their farm land and harvest optimum amount of crops yearly.

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