Full Length Research

Chemical Fertilizer Marketing and Uptake in Ethiopia: Evidence from Ada`a District of Oromia Regional State

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Agricultural Development Led Industrialization has been the main development strategy of Ethiopia since 1990s. The strategy promotes transformation of the smallholder agriculture through diffusion and adaptation of agro-ecology sensitive and labor-intensive agricultural technologies and practices. However, the adoption and application of modern agricultural inputs [chemical fertilizer] has been low even in Sub-Saharan African standards. The underlining factors that hold application of fertilizer low are multifaceted and beyond this piece of inquiry. This paper thus analyzes the chemical fertilizer market chain and uptake by smallholders in Ada`a district of Oromia Regional State. It measures the current actual state of fertilizer application in the study area. The paper also highlights the main challenges of fertilizer uptake in the district. The research paper employed a desk review of macro and micro household survey research results of Agricultural Input supply system in Ethiopia and a rapid key informant interview with agricultural experts and Cooperative Managers. To this effect, the paper found that the government has long been monopolized fertilizer marketing. Fertilizer has always been nationally recommended without locally affirmed dose to date. The application of fertilizer has hence been suffered from ecological and composition fallacies in the country. This paper measured chemical fertilizer uptake and use in terms of total fertilizer supplied, percentage of farmers using fertilizer, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare. The volume of chemical fertilizer uptake in the district has not been increasing nor decreasing in the last five years. The paper also affirmed that all of the smallholder farmers in the district have been using fertilizer irrespective of the dose of application per hectare.

Key words: Chemical fertilizer, Fertilizer marketing, value chain, fertilizer uptake

INTRODUCTION

Agriculture plays a crucial role in growth and development of developing countries. There is strong evidence that agricultural growth has a high poverty reduction pay-off. Analysis by IFAD (2013) and the World Bank (2007) shows that a 1 percent per annum increases in agricultural growth leads to a 2.7 percent increase in income of the lowest three income deciles in developing countries. Investment in agriculture is 2.5 to 3.0 times more effective in increasing the income of the poor than in non-agricultural investment. Agricultural growth, as opposed to growth in general, is typically the primary source of poverty reduction. In the contrary, a decline in agricultural growth throws many poor people into poverty. This explains some of the increase in poverty and hunger in developing countries during 2008 and 2010, when food prices increased worldwide (IFAD, 2013). Despite this strong nexus between agricultural growth and poverty reduction, the rural poor in Africa has been unable to move out of poverty because of the failure to transform their basic economic activity—agriculture —to high productivity levels (AGRA, 2013).

In Ethiopia, agriculture accounts about 41.6 percent of the GDP, employs about 83 percent of the labor force and contributes around 90 percent of the total export earnings of the country. The sector is dominated by about 11.7 million smallholders cultivating about 95 percent of the national agricultural production and large farms contributed to only 5 percent of the total production (MOA, 2011). This shows that the overall economy of the country and the food security of the majority of the
population depend on small-scale agriculture. Hence, agricultural growth and development remains the last resort to take-off the national economy. In cognizant to the fact that science and technology plays a central role in development of agriculture as witnessed in the green revolution in Asia, the government of Ethiopia formulated Agricultural Development Led Industrialization policy in 1993. The policy promotes transformation of the smallholder agriculture through diffusion and adaptation of agro-ecology sensitive and labor-intensive modern agricultural technologies and practices (MOFED, 2010).

Empirical evidences, however, re-affirm that development, adoption and application of modern agricultural inputs (chemical fertilizer, improved seeds, pesticides and irrigation) remains low in Ethiopia. The sector is characterized by low input-output rain-fed smallholder farmers. Chemical fertilizer use for example is low. Only 30–40 percent of Ethiopian smallholders use fertilizer (Spielman et al., 2013). The physical application rates of fertilizer are also well-below those recommended by the extension programs; on average only 37–40 kilogram per hectare in 2013 compared with an average of 102.0 kg fertilizer use per hectare across Asia in 1995 (Hazell, 2009) and about 9 kg nutrients per hectare in Sub-Saharan countries (Belay, 2003). The adoption of fertilizer responsive improved seed has also been discouraging in Ethiopia. For instance, farmers used improved seed covered an average of only 4.7 percent of cropped area in 2007/08 cropping year (Spielman et al., 2011). The low applications of agricultural inputs keep the agricultural production and productivity low and made the country one of the food insecure nations of the world. The major reasons behind the poor performance of the Ethiopian agriculture and the existing structural food insecurity in the country can be summarized to poor input supply system and institutional capacity (limited capacity of agricultural extension), market imperfections, poor research-extension farmers linkage and the low level of agricultural technology development, adoption and discontinuance which deter the efficient utilization of the country’s natural resources (Belay, 2003). The central question of the paper is thus being the priority agenda of the government since 1990s, why has chemical fertilizer adoption and application been quite below the recommended in Ethiopia? Indeed, the paper intends to explore the trends and chains of chemical fertilizer demand and supply in Ada’a district of Oromia Regional State. It also analyzes the current actual state of fertilizer application in the study area.

METHDOLOGY

Data collection and analysis method

The research paper employed a desk review of macro and micro household survey research results of Agricultural Input supply system in Ethiopia and a rapid key informant interview with Ada’a woreda agricultural office experts, and Erer Farmers Cooperative Union and Primary Cooperative Managers and experts. The desk review relied on analysis of the existing literature on agricultural inputs supply system, as well as current agricultural policies and strategies in Ethiopia. Thus, the review materials used in this research included journal articles, books, and policy papers, official and other relevant documents to the study. It is therefore important to note that the findings of this paper are derived from primary and secondary data analysis.

Theoretical and empirical evidences

Theoretical explanation of fertilizer in Ethiopia

Theories provide principles that can guide researchers in the course of their research process without which research becomes an empty process. Economic development theories explain the casual interrelationships among economic variables. They also provide a foundation to understand the world better and can guide a policy. There are a number of theories in the social science research. It is, therefore, important to researchers to identify and establish a theoretical foundation that can explain their argument in the course of their research. The theme of this paper is to explore chemical fertilizer value chain and uptake in Ada’a district of Oromia Regional State. The paper examines technology transfer [chemical fertilizer] in which modernization theory constitutes and explains it sufficiently. Chemical fertilizer was introduced to Ethiopia under the Freedom from Hunger Program of the FAO in the late 1960s as an economic policy prescription of the modernization theory of the Post World War Development Project and the marketing system of the product has come through the classical and neo-classical theoretical underpinning of market whereby the subsequent governments have monopolized chemical fertilizer supply at some point in time and liberalized at other times. As it is detailed in the forthcoming pages, fertilizer marketing in Ethiopia has come through complete government monopoly, partial liberalization, liberalization and again complete government control since 2001 (IFPRI, 2012; Rashid et al., 2013).

Modernization theory is the extension of the early European enlightenment. Modernization theory, developed by American social scientists in the mid-1950s, believed in the existence of a linear path from tradition to modernity that every society could, and should, take (Unger, 2007). The modernization theory has structural and psychological dimensions in which the structural dimension of the theory constitutes a uniform, evolutionary vision of economic, social and political development along the path of the industrial First World
which is based on capitalism and democracy. Rostow (1960) has constructed and structured modernization theory in his well-known book entitled “The Stages of Economic Growth”. Rostow postulated five successive economic growth stages in which societies should undergo in order to modernize and achieve economic development.

In the Traditional Society (1st stage), economic system is stationary and dominated by agriculture with traditional cultivating forms. Productivity per man-hour is low compared to the next growth stages. Production is labor-intensive using only limited quantities of capital. Technology is limited, and resource allocation is determined very much by traditional methods of production. The Preconditions for Take-off constitutes agricultural transformation and industrial revolution through adoption of modern technologies. Infrastructure development, emergence of entrepreneurship, savings and investment and primary goods export are the main features of this economic growth stage. A strong central government encourages private enterprise. The Take-off Stage is characterized by dynamic and self-sustained economic growth which requires no exogenous inputs. It involves rapid capital accumulation and early industrialization. Labor and capital shift from agriculture to non-agriculture sector to foster and realize the high industrialization of the Drive to Maturity economic growth stage of Rostow. The economy is diversifying into new areas. Technological innovation provides diverse range of investment opportunities. The economy is producing a wide range of goods and services and there is less reliance on imports. The highest economic growth stage is the Age of High Mass Consumption where the economy gears towards mass consumption, and the level of economic activity is very high. Technology is extensively used but its expansion slows. The service sector becomes increasingly dominant (Rostow, 1960).

To further modernization process, the already-modern nations had a duty to help the backward societies begin and reach what Rostow called Take-off (Unger, 2007). Lopez-Alves (2011) also underscores that the modern countries are designated to generate the technologies and models while the traditional societies can adjust it to their condition. The intrinsic value of modernization theory was westernizing the non-western world in all aspects of human life. Economically, modernization was meant diffusion of a development model and technologies from a modern society to the traditional society through the “Cope up the economic model of the west to catch up the west orientation”. At this point in time, the economic policy prescriptions and the intrinsic social values of modernization theory were imposed in Africa; dictating the continent to follow unless otherwise, will remain poor. As quoted in (Matunhu, 2011) Ellis and Biggs argued that policies intended to raise the standard of living of the poor often consist of disseminating knowledge and information about more efficient techniques of production. For instance, the agriculture modernization process involves encouraging farmers to try new crops, new production methods and new marketing skills (2001). In general, modernization led to the introduction of hybrids, the greenhouse technology, genetically modified (GMO) food, use of artificial fertilizers, insecticides, tractors and the application of other scientific knowledge to replace traditional agricultural practices (Matunhu, 2011). Thus, the primitive agrarian societies can therefore be regarded as modern if and only if they transform the subsistent agriculture to commercial agriculture through the introduction and adoption of the modern agricultural technologies and practices of the west no matter where they are. At this junction, western born modern agricultural technologies and techniques like chemical fertilizers and improved varieties were introduced to Ethiopia as a policy prescription to modernize the sector. But before we review the introduction to and evolution of chemical fertilizer in Ethiopia, let us look at the brief history of agricultural extension system which guided the evolution of chemical fertilizer in the country.

Empirical evidence

Agricultural extension system in Ethiopia: The formal agricultural Research system of Ethiopia has long been generating a number of agricultural technologies and inputs. However, these technologies and inputs have not been backed up by innovative practices in order for farmers to make use of them. Appropriate Agricultural Extension which originally meant enlightenment of local people to promote local innovations is very important in order to unleash the power of scientific knowledge and suit it with the indigenous knowledge. Indeed, the Ministry of agriculture has implemented different extension approaches, such as the Comprehensive Package Program, the Minimum Package Program, the Peasant Agriculture Development Extension Program, the Training and Visit Extension Approach and since 1995, the Participatory Demonstration and Training Extension System (Belay, 2003) over the years. However, these subsequent Agricultural Extension Approaches and Strategies implemented over the last half a century have not brought about a significant change in the smallholder agriculture of the country. The “Western-born Agricultural Innovations” have been designed on the National Research Centers and trickled-down to the smallholders. In other words, the contemporary state-run agricultural extension systems and strategies have been geared towards resourceful farmers and have left the resource-poor smallholder farmers under poverty trap; principally because the subsequent extension approaches and strategies pursued have been stemmed from the top-down supply driven development approach which labels farmers as the “passive recipients” of agricultural
technologies; be it relevant or irrelevant to their farming conditions; from the center; usually the “scientists”. The contemporary Participatory Demonstration and Extension Training System diffuses agricultural technologies to model farmers and then slowly to progressive farmers to outreach the whole community has not benefited the massive smallholders.

The recent promising national economic growth of the country predominantly comes from favorable weather conditions and resourceful model farmers and other sectors (service and industry) leaving the mass smallholders with farm as usual. There has been little deviation between the agricultural production system of the smallholders and their ancestors. The smallholders are still tilling their starved plot of lands either through hoe or oxen. This clear evidence of sluggish change in small-scale agriculture coupled with persistent rural underdevelopment has recently pushed the government to shift from “Diffusion of Agricultural Innovations” to “Scaling up of Innovations and Best Practices”. But let us first highlight what scaling up means. The recent promising national economic growth of the country predominantly comes from favorable weather conditions, large-scale agriculture and resourceful model farmers and other sectors (service and industry) leaving the mass smallholders with “farm as usual”. There has been little deviation between the agricultural production system of the smallholders and their ancestors. The smallholders are still tilling their starved plot of lands either through hoe or oxen. This clear evidence of sluggish change in small-scale agriculture coupled with persistent rural underdevelopment has recently pushed the government to shift from “Diffusion of Agricultural Innovations” to “Scaling up of Innovations and Best Practices”. But let us first highlight what scaling up means. The recent promising national economic growth of the country predominantly comes from favorable weather conditions, large-scale agriculture and resourceful model farmers and other sectors (service and industry) leaving the mass smallholders with “farm as usual”.

**Evolution of chemical fertilizer in Ethiopia:** Modern agricultural technologies constitute the introduction and use of hybrids, the green house technology, genetically modified (GMO) food, chemical fertilizers, insecticides, tractors and the application of other scientific knowledge (Matunhu, 2011). The scope of this paper is nevertheless limited to chemical fertilizer which constitutes the key means for increasing yields per hectare.

Chemical fertilizer was first introduced to Ethiopia under the Freedom from Hunger Program of the FAO in the late 1960s (Agricultural Transformation Agency, 2012 - unpublished). Despite successful field demonstrations and several deliberate policy attempts to increase fertilizer use in the late 1970s and early 1980s, fertilizer application levels remained very low (Agricultural Transformation Agency, 2012 - unpublished). At the national level, total imports of fertilizer increased from about 3,500 tons in the early 1970s to only 34,000 tons in 1985/86. With the introduction of the Peasant Agricultural Development Program (PADEP) in 1986, total imports of chemical fertilizer reached about 140,000 tons by the time the central planning regime of the Derg collapsed in 1991. In contrast, it grew from 140,000 tons in the early 1990s to about 890,000 tons in 2012 (Rashid et al., 2013). Since 1992, there have been a number of policy shifts that have shaped and re-shaped fertilizer supply in the country. The unpublished Ethiopian Agricultural Transformation Agency (2012) document prepared by the IFPRI (2012) and Rashid and his colleagues at the same institute (2013) have summarized the policy shifts into: (I) complete government control (1967-1992), (II) partial liberalization, with private sector entry and elimination of subsidies (1992-1996), (III) competition among public, private, and regional holding companies (1997-2000), (IV) exit of private companies (2001-2006), and (V) since 2007, the exit of regional holding companies and the entry of farmers’ cooperatives as the distribution channel, with AISE as the sole fertilizer importer since 2008. From the earliest days of field-level fertilizer demonstration plots to the collapse of central planning in 1991, fertilizer markets in Ethiopia were controlled by the government through its parastatal input marketing agency, called Agricultural Inputs Supply Corporation (AISCO), which was re-named as Agricultural Inputs Supply Enterprise (AISE) in 1992. The AISCO had its own marketing
network throughout the country, which included marketing centers and service cooperatives for distributing fertilizers to the farmers. Like in many African countries, AISCO controlled marketing was inefficient and expensive, involving government subsidies to cover its large administrative costs (ATA, 2012 - unpublished).

A clear manifestation of the aforementioned policy shifts is the sharp increase in fertilizer imports, which jumped from 440,000 tons in 2008 to 890,000 tons in 2012. However, fertilizer availability (import plus change in stocks) far exceeded total use, resulting in large carry-over stocks reaching almost half a million tons in 2012—worth roughly US$350 million—sitting idly in cooperative warehouses throughout the country. The growing problem with carry-over stocks implies a mismatch between the government’s targets and the effective demand of fertilizer under the current policies, infrastructure, and institutions. Yet, fertilizer use in the country is low (IFPRI, 2013). According to Spielman, Alemu, and Kelemwerk (2013), only 30–40 percent of Ethiopian smallholders use fertilizer with only 37–40 kilogram physical application per hectare (ha), significantly below recommended rates.

Through the New Marketing System, introduced in 1992 as part of its overall market liberalization policies, the transitional government articulated its desire to end government monopoly. However, private sector entry into the fertilizer sub-sector in Ethiopia was slow in the early years of liberalization. Only one private company, Ethiopian Amalgamated Limited, actively participated in fertilizer imports and distribution until 1996. Subsequently, three additional companies entered the market and actively tried to develop their own fertilizer marketing channels. At around this time, regional government companies, mostly affiliated to the ruling party, began fertilizer business. The first such company to enter was Ambassel Trading PLC, owned by the Amhara regional government. Until 1995, Ambassel worked mainly as an agent of the AISE. However, it started importing fertilizer in 1996 on its own, while continuing to serve as the sole distributor and wholesaler of AISE in the Amhara region. Inspired by Ambassel Trading, other regional governments launched their own companies—Dinsho in Oromia, Wondo in SNNP, and Guna in Tigray. By 1998, the holding companies of all four major grain-producing regions were importing and distributing fertilizers alongside AISE and four private fertilizer companies. However, this state of competition in fertilizer supply between government, private, and regional holding companies was short lived. The share of total fertilizer imported by private companies declined from 28 percent in 1996 to zero in 2002.

Cooperatives have been involved in input marketing in Ethiopia since the 1970s, but they became dominant from 2006. In the new millennium the government adopted a strategy to develop an input marketing system with strong participation of farmers’ organizations. The initiative was welcomed because it was also one of the policy prescriptions emerging from the development partners for addressing the problems of thin markets and product aggregation problems. This was an aggressive strategy, and the cooperatives’ market share grew rapidly, reaching almost 75 percent of the total fertilizer use in 2007/2008. This rapid growth was promoted by providing subsidized credits to the cooperative unions to import and distribute fertilizer. However, the policy faced problems due to the rising cost of fertilizer and a balance of payment problems during 2007/2008 (Rashid et al., 2013). According to World Bank (2009) in the same source revealed that the government requested financial support from its development partners for and managed to receive USD 250 million from the World Bank and another fund worth 100,000 tons of fertilizer from the African Development Bank. Through some negotiations, the government and the two banks agreed to coordinate all fertilizer imports through AISE. This policy decision resulted in withdrawal of all holding companies except Wondo from fertilizer markets in Ethiopia.

**Fertilizer use patterns in Ethiopia:** The uptake and use of chemical fertilizer in Ethiopia (primarily DAP and urea) can be assessed in several ways—in terms of total fertilizer imported, percentage of farmers using fertilizer and improved seed-fertilizer packages, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare (Spielman et al., 2013). Chemical fertilizer is primarily used in cereal production in Ethiopia. According to Ministry of Agriculture in Rashid et al. (2013), cereals account for 90 percent of the country’s total chemical fertilizer application with only Oromia and Amara regional states accounted for 70 percent of total use during 2005/2006–2010/2011. The shares of the other two major cereal-growing regions—the Southern Nations, Nationalities, and Peoples’ Region (SNNPR) and Tigray—were 10 and 3 percent, respectively.

Research done by the team of researchers in IFPRI (2013) on the chemical fertilizer application trend in Ethiopia revealed that there has been an increasing trend in both planted area and fertilized area. While planted area has increased from about 7.0 million hectare in 2003/04 to 9.7 million hectare in 2010, representing a 38.6 percent growth, fertilized area has more than doubled from 1.12 million hectare to 2.31 million hectare during the same time. The study further found that more teff area appears to receive fertilizer than any other cereal crops in all the cereal growing regions except SNNPR. At the national level, teff has consistently accounted for more than 40 percent of fertilized land. In 2010/11, of the total fertilized area of 2.31 million hectare, 981,000 hectare was allocated to teff, which is almost 75 percent more than maize or wheat. It may seem counterintuitive that farmers are using more fertilizer in a low-yielding crop like teff. However, this is consistent with
the fact that teff prices have been increasing in real terms for many years. As a result, price has become more favorable relatively for teff than for other cereals. In addition, due to ease of storage and long shelf life, farmers attach some intrinsic values to teff. On the other hand, fertilizer use in other cereals (barley, sorghum, rice, and millet) has been minimal relative to the three major cereals and the land allocated to them. Since 2003/04, about 2.6 million hectare, equivalent to 35 percent of total planted land, has been allocated to these cereals; but only about 4 percent of this land is fertilized implying the economics of fertilizer use in these non-tradable cereals has not been favorable (IFPRI 2013).

RESULTS AND DISCUSSION

The current chemical fertilizer demand and supply chain in market principle, the shortest the chain between the producers and consumers of a product, the cheapest the price of the commodity. Wherever produced, the market chain and price of chemical fertilizer should also not be different from this principle. The chemical fertilizer demand and supply value chain in Ethiopia goes through enormous steps and involves a number of actors who plan the yearly total demand of chemical fertilizer of the country, bid in the international market, import execution, fertilizer marketing and distribution. The annual national demand and import planning begins with an assessment of fertilizer demand of each farmers for the next agricultural year at kebele level. As depicted in Figure 1, the district agricultural office collects the expected annual fertilizer demand of farmers at kebele level. This collection is usually done by Agricultural Extension Frontline Workers (Development Agents) who work at kebele level. After aggregating the kebele level demand of fertilizer to generate district level annual demand estimates, the district Agriculture Office sends the aggregated estimates to the Zonal Agricultural Bureau and Cooperative Unions (disaggregated kebele level demand).

The Zonal Agricultural Bureaus then aggregate all of the data from the woredas in each Zone and send these estimates to the Regional Bureau of Agriculture, who estimates the aggregate regional fertilizer demand for the coming cropping year. Thereafter, the Regional Bureau of Agriculture sends the aggregate annual fertilizer demand of the region to the Ministry of Agriculture. The Ministry of Agriculture then aggregates the regional estimates to fix the national demand for fertilizer expected in the coming agricultural year. Once the current national demand is estimated, the net import requirement is calculated by deducting the carry-over stocks from the previous year from the estimated demand for the coming year. Finally, the Ministry of Agriculture prepares tender documents and invites to the Ministry of Finance and Economic Development, the National Bank of Ethiopia (NBE), the Commercial Bank of Ethiopia (CBE) and the Quality and
Standards Authority of Ethiopia to review and approve the details of the request for tenders, including the foreign exchange requirements. This consortium of institutions is also responsible to opening and evaluation of the tenders offered by international fertilizer suppliers to approve the winner(s) of the bidders for actual fertilizer importation. Once the Net Annual Fertilizer requirement of the country is known and approved by the consortium (National Fertilizer Procurement Steering Committee), the Ministry of Agriculture orders to the Agricultural Inputs Supply Enterprise (AISE) to execute the fertilizer importation process. As stated in the preceding pages, chemical fertilizer importation has been carried out exclusively by the Agricultural Inputs Supply Enterprise of the country since 2008. According to the Cooperative Union managers, this economics of scale – importing fertilizer in bulk has enabled the Agricultural Inputs Supply Enterprise to have more market bargaining power to negotiate lower prices, reduce transaction costs (the most important factor in Ethiopia), and significantly improved the timely delivery of fertilizer to farmers. On the other hand, the price of fertilizer has been steadily increasing in the last five years and farmers are complaining the late delivery of fertilizer causing rejection to buy and hence carry-over stocks and unnecessary expenses.

When we turn to the supply side, the chemical fertilizer importation, marketing and distribution passes through many steps and involves many actors. According to IFDC (2012), the Commercial Bank of Ethiopia issues letters of credit on behalf of Agricultural Inputs Supply Enterprise to procure the fertilizer and makes payments to the international fertilizer supplier. The bank provides credit to the cooperative unions backed by the credit guarantee of the regional Bureaus of Agriculture. The regional Bureau of Agriculture in consultation with regional cooperative agencies set fertilizer prices and margins for the cooperative unions and the primary cooperatives and also provides credit guarantees for the unions to obtain and transport fertilizer from the Agricultural Inputs Supply Enterprise warehouses. All in all, the fertilizer supply chain and marketing in the country is long and complicated, and hence needs an urgent remedy of one window service delivery.

### Chemical fertilizer uptake

The uptake and use of chemical fertilizer (primarily DAP and Urea in Ethiopia) is measured in terms of total fertilizer supplied, percentage of farmers using fertilizer and improved seed-fertilizer packages, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare (Spielman et al., 2011). This paper tries to examine the uptake and use of chemical fertilizers in the district using these indicators.

As depicted in Figure 3, the Agricultural Inputs Supply Enterprise (AISE) has been the only chemical fertilizer importer in Ethiopia while cooperatives are the sole wholesalers and distributors in the country. The Cooperative Unions are responsible to channel the fertilizer to the Primary Cooperatives which in turn are responsible to distribute it to the farmers. Erer Farmers Cooperative Union supplies and distributes to the primary cooperatives in the districts. Thus, we measured the quantity of the district chemical fertilizer supply using Erer Farmers Cooperative Union series data. The Cooperative Union has increased fertilizer supply to the primary cooperatives in the district from 53022.75 quintals in 2009 to 65305.5 quintals of product in 2014. Fertilizer importation needs foreign exchange and hence estimation and importation of the exact amount of the product for a particular cropping year is important. However, fertilizer carry-over has long been a critical concern in the locality. As depicted in Table 1, the actual distribution of fertilizer grew from 60570 quintals in 2010 to 67172.5 quintals in 2014 only. The fertilizer supply increment was a fold of the actual distribution of fertilizer in the district signifying the presence of huge fertilizer carryover stock year after year. The carryover deteriorates the quality of fertilizer and its farm-gate price. As we shall see later, the higher the carryover stocks of fertilizer, the higher the price of the product in the next
The intensity of fertilizer uptake can also be evaluated using the number of farm households using fertilizer in the district. Data obtained from the office of agriculture of the district revealed that all of the farm households (Table 2) have been using chemical fertilizer irrespective of the dose of application per hectare. This figure is quite high compared with the national average estimated at about 37 percent of fertilizer users in the major cereal-growing areas.

We also measured the trend of fertilizer uptake by calculating the percentage of cultivated land under fertilizer application in the last six consecutive agricultural years. Out of the total 73087 hectares of cultivated land in 2009 in the district, only 54787 hectare of land (75 percent) was fertilized. The fertilized land decreased from 54787 hectare (75 percent) of land in 2009 to 43095 hectare (65.56 percent) of land in 2014. Equally important is the size of cultivated land which has decreased by 7357 hectare (10 percent) from 73087 hectare in 2009 to 65730 hectare in 2014 due to investment and urban expansion in the district. When sum up the trend of fertilized land under cultivation, we can say that fertilizer uptake in the district has not been increasing nor decreasing in the last five years.

It has long been an overriding research question why...
crop productivity and production in Ethiopia are low and stagnant despite the large emphasis given to agriculture sector. This central research question leads us to study whether farmers apply fertilizer optimally based on the recommended dose or not. This is because crop productivity improvement is merely possible under optimum application of agricultural inputs. As depicted in Table (2), the trend of fertilizer supply in the district has been varying; the highest and the lowest being 70239.5 and 355492.3 quintals in 2012 and in 2014 agricultural years respectively. However, the physical application rate of fertilizer at household level is still below the recommended dose. When measured in terms of kilogram per hectare of cultivated land, the current chemical fertilizer application rate is estimated at 51.1 kilogram per hectare. When measured in terms of kilogram per hectare of land under grain production, the application rate is estimated at about 72.5 kilogram per hectare. When measured in terms of kilogram per hectare of fertilized land under cultivation (which accounts for 65.5 percent of all land cultivated in the district), the figure increases to 77.9 kilogram per hectare of land. As we can observe from Table 3, the average physical application of fertilizer per hectare of land grew from 53.7 kilogram in 2010 to 77.9 kilogram per hectare of land in 2014. Despite the promising progress registered in the last few agricultural years, the average physical application of chemical fertilizer per hectare of land is still low compared to the recommended dose given by agricultural experts leading to low production and productivity of crops. Fertilizer wise, the current average application of DAP per hectare of land is
estimated at 89.2 kilogram per hectare while the average application rate of Urea per hectare measured at 66.7 kilogram per hectare of land which shows the inappropriate combination of the fertilizers. Farmers tend to use and apply more DAP compared to Urea in the study area. The result coincides with Kefyalew (2011) who found low application and improper combination of DAP and Urea fertilizers using the Central Statistical Authority (CSA) data and the Ethiopian Rural Household Survey. He further revealed that such low application and improper combinations resulted in low respond and magnitude of crop production and productivity at national level.

The low gross crop production and productivity in the country has also been attributed to the crop limited application of fertilizer. Teff and Wheat are the major crops grown in the district. Pulses particularly chickpea is also commonly grown in the area. Macro and household level application of fertilizer studies show that teff, wheat, and maize cultivation account for the majority of fertilizer use in Ethiopia. In the same vein, the paper tried to assess whether farmers are applying fertilizer to all crops or not. Corresponding to the crop selective fertilizer application fact in the country, Table 4 shows that only teff and wheat crops account the whole fertilizer application in the district. In other words, farmers have been applying fertilizer on Teff and Wheat crop lands only. In general terms, the physical application of fertilizer on crop land shows an increasing trend. The current application rate of fertilizer to teff and wheat crops is similar; estimated at about 73.7 kilogram per hectare of land. This application rate is quite below the blank recommended dose in Ethiopia. On the other hand, no other crops have been receiving fertilizer in the area which jeopardizes the productivity and production increment of the sector. The paper argues that crop production and productivity increment seem difficult otherwise impossible in the current scenario and scope of fertilizer application in the district. Therefore, it is plausible to optimize fertilizer application and extend and apply it to other crops.

**Fertilizer price trend**

The high price of fertilizer relative to the resource-poor smallholder farmers has long been a national concern in the country. The recent discontinuance of farmers to use fertilizer has also been evident to the high price of fertilizer in the country (Kefyalew, 2011). A recent macro level analysis using the Central Statistical Authority (CSA) and the Ethiopian Rural Household Survey (ERHS) data shows that the high price of fertilizer is the major constraint (47.6%) for fertilizer application followed
by supply shortage and late arrival of fertilizer in the country (Kefyalew, 2011). Though fertilizer price in Ethiopia is low relative to other neighboring countries (Rashid et al., 2013), it has steadily been increasing in the past years. The price increment might be attributed to the international fertilizer market and ocean freight which the government could have little to do with, poor institutional and infrastructure development where transport cost alone contributes to about 64 to 80 percent of the price differential between the landed cost at Djibouti port and the farm gate price (Rashid et al., 2013); and the long chain and multiple profit margins and administration costs. Table 4 shows that the farm-gate price of DAP has increased almost by one fold from 674.91 ETB per quintal in 2010 to 1333.29 ETB in 2014. The price of Urea also grew from 603.07 ETB to 961.68 ETB in the same period. The absence of access to credit for agricultural inputs in general and fertilizer in particular coupled with absence of dependable fertilizer packing further affects fertilizer uptake in the area. The price of fertilizer has also been increasing along with carryover stock increment of the product in the warehouses of the cooperatives.

The cost building and price determination processes are also important contributing factors to the steady fertilizer price hike in Ethiopia. Fertilizer costs are built and rebuilt at different levels in the country leading to higher farm gate price. The Agricultural Inputs Supply Enterprise has solely been controlled by the supply of fertilizer in the country since 2008. In such monopolistic market, there are two arguments: (1) given the single price maker, the price of the product could be high and (2) the economics of scale and the absence of competitors who want to make profits across the supply chain may also lower the price of the product. This paper tries to look at the fertilizer price setting and cash flow in the agricultural input supply system of the country from these perspectives. In general terms, the Ministry of Agriculture determines the national selling price of fertilizer in Ethiopia. However, as shown in Figure 3, fertilizer price is set now and then at different levels of the supply chain affecting the final farm gate selling price of the product.

The Agricultural Inputs Supply Enterprise proposes the total national demand of fertilizer and its selling price to the Ministry of Agriculture. This selling price estimation constitutes the total cost of the carry-over stocks of the previous year (procurement price, transport cost, bank interest, profit margin of AISE and other administration costs) plus the total cost (procurement price, transport cost, bank interest, profit margin and other administration costs) of the demand of the coming agricultural year. Based on the AISE proposal, the Ministry of Agriculture fixes warehouse-based selling price of fertilizer at national level and circulates this national selling price to regional agricultural bureaus and Regional Cooperative Agencies. In the same vein, the Regional Agricultural Bureau in collaboration with the Regional Cooperative Agencies set warehouse-based selling prices in their respective regions. The agencies subsume the total cost of the carry-over stocks of the previous year (procurement price, transport cost, bank interest, profit margin of the agency and other administration costs) plus the total cost (procurement price, transport cost, bank interest, profit margin of the agency and other administration costs) of the demand of the coming agricultural year and sends this selling price to Zonal Cooperative Agency. Finally, the Zonal Cooperative Agency fixes the final farm gate selling price of fertilizer in the same way. This Zonal final selling prices estimation constitutes the profit margins of the Cooperative Unions and primary Cooperatives and transport cost to the particular kebele. This long chain and multi-level selling price setting makes farmers to pay double payments to fertilizer. Thus, it can be said that the long chain and repetitive selling price setting not only increases the farm gate price of fertilizer but also leads farmers to unnecessary expenses. Given the vast international market, whatsoever the fertilizer demands of Ethiopia could not affect the international price of fertilizer. Hence, the paper argues that the steady fertilizer price increment in the country might be the result of the repetitive profit margins, high transaction costs and other administration costs across the inputs supply system.

### Challenges of chemical fertilizer use

Agricultural transformation has been the headline of the Federal Democratic Republic of Ethiopia almost for the...
last two decades. However, despite the recent promising records, the sector has not been transformed to the scale it can support the growing population. The overriding question here is that being the priority agenda of the government for decades, why has the agricultural sector not been changed to the level it can support the growing population of the country? Does the smallholder farmers have the drivers of success and the necessary policy and institutional support to take off the agricultural sector; say for instance; like the Asian Green Revolution? The 20th century scientific revolution in agriculture had abolished the chronic famine and hunger in Asia and the resultant increases in food production pulled the region back from the edge of an abyss of famine and led to regional food surpluses within 25 years (Hagell, 2009). According to Hagell the Asian Green Revolution was driven by a technology revolution constituting a package of modern inputs – irrigation, improved seeds, fertilizers, and pesticides – that together dramatically increased crop production and a supporting economic and policy environment (2009). This shows that the preconditions and challenges of agricultural transformation are multidimensional and beyond the scope of this paper to delve. Thus, the paper tries to present the peculiar challenges of fertilizer use only in the district.

Weak fertilizer demand estimation system: The annual fertilizer demand estimation process is long and involves a number of stakeholders. The estimation begins at household level where farmers report their annual fertilizer demand of the next agricultural year to development agents who work at kebele level. The chain goes on through the district and zonal agricultural office, regional agricultural bureaus to the ministry of agriculture who is responsible to compile and determine the national fertilizer demand of the country (Figure 2). The annual national fertilizer demand had been estimated based on the size of the cultivated land in the country. Such office based estimation has led the country to unnecessary foreign exchange expenses and large carry-over stocks idly stored at the primary and cooperative union warehouses which imply a mismatch between the annual demand estimation and the effective demand of fertilizer. This mismatch and large carry-over has also been a contentious issue even at national level until recently. To move out of it, the government has taken a serious measurement and decided to collect the annual demand of each farmer via the development agents. However, given the poor planning culture of farmers, the issue is still a big concern which needs special attention. Furthermore, the subsistent agriculture heavily depends on rain-fed and hence the smallholder farmers rely on rainfall which varies occasionally to cultivate crops. When rainfall varies, farmers fail to take up the quantity of fertilizer they planned leading to over estimation which results on carry-over, quality deterioration and price hike of the product.

Long fertilizer supply chain and late delivery: the Agricultural Inputs Supply Enterprise (AISE) has been the sole importer of fertilizer in Ethiopia since 2008. This complete control of fertilizer importation has been enabling the government to take an advantage of economies of scale (bargaining power in the international market and transport cost) but the long domestic supply chain (Figure 3) and absence of competition compounded by the poor infrastructure development has led to late delivery of fertilizer to farmers. All the key informants at the (Eer) Farmers Cooperative union, Ada’a woreda Agricultural Office and the office of the cooperative have unanimously reported that late delivery is still a big concern which needs an immediate remedy. A household survey made by Bonger et al. (2004) found that half of the farmers have reported that fertilizer arrived after planting while 40 percent of the surveyed farmers delayed their crop plantation due to late delivery of fertilizer. National household studies have also reported similar results that farmers have complained of late delivery of fertilizer (DSA, 2006) and EEA/EEPRI (2008). This implies that the recent shift to and measurement taken by the government to monopolize importation and distribution of fertilizer has not overcome the late delivery problem.

Absence of Agricultural input supply subsidies and access to credit: it has long been since the government ceased subsidizing fertilizer supply. The government has cancelled the subsidy arguing that the smallholder farmers have the capacity to purchase the inputs on cash bases. Farmers have also been denied to purchase fertilizer on credit bases. They are obliged to purchase fertilizer on cash basis. The key informants, however, revealed that such cash based fertilizer marketing have been benefiting the model and resourceful farmers only.

Limited alternatives and package of fertilizer: The Agricultural Inputs Supply System suffers from two intertwined, ecological and compositional, fallacies (Dercon and Gollin, 2014) both of which are very common in Ethiopia. The ecological fallacy underlines that what works at one scale will work at another scale while the compositional fallacy underpins what is good for one person is good for everyone. Modernization theory is the mother and father of these fallacies. As discussed in the preceding pages, the agricultural policy prescription of modernization theory has been to transfer agricultural technologies and knowledge from the west to the rest of the world usually labeled as underdeveloped. That means the agricultural technologies proved to be effective in the western ecology would be effective across the world. The fertilizer supply and distribution system in Ethiopia has been based on this philosophy. The fertilizer supply has been confined to only DAP and Urea since the introduction of the technology in 1960s. Given the diversified nature of the agriculture, however, the application of the same technology across the country
has brought little change in the productivity of the sector. The provision of DAP and Urea across the country has, sometimes, been the same with provision of soil nutrients which are already adequate in the soil. The agricultural experts in the district have noticed that the supply of the same fertilizer technologies and the absence of alternatives have not only contributed little to the productivity of the sector but also a source of conflict between the frontline development practitioners and the smallholder farmers. The compositional fallacy has also not been uncommon in the country. The country has not been offering fertilizer in smaller packages that could be used by smallholders. Fertilizers are usually offered in 50 kilogram bags which make the smallholder farmers not to purchase it easily. In the same vein, Ethiopia does not offer chemical fertilizers in different formulations needed for different types of agro-ecologies, soils, and crops. Besides the long term adverse productivity and environmental impacts of fertilizer, farmers are fading using up of these products, added the key informants.

Institutional arrangements and professional incentives: The structure of an organization directs where resource can flow and who does what to execute a particular plan in a given sector. So, the structure of the organizations should be well-articulated and show resource requirements, accountabilities, duties and responsibilities of each position in the structure in order to implement the development plans at grass-root level (Girmay and Mare, 2014). In the same vein, the paper tried to assess whether the institutions are arranged in such a way that foster fertilizer delivery to the end users. The agricultural institutions and the job descriptions in each position are well-structured and articulated. What matters has been the shortage of resources and professional incentives in the district. According to the key informants, the development agents who are responsible to train and demonstrate the smallholders about fertilizer application are not happy with their salaries and incentives and hence there is high turnover.

Concluding remarks

This paper questions why chemical fertilizer adoption and application has below the recommended level in Ethiopia. The paper explores chemical fertilizer market chain and uptake by smallholders in Ada’a district of Oromia Regional State. The overwhelmingly domination of modernization theory on modern agricultural inputs supply system in the country has been manifested through (1) the origin and nature of the technology, (2) the subsequent implementation of top-down agricultural policy and strategy prescriptions resulting in resistance to use modern agricultural inputs by farmers and (3) the market irregularities. Chemical fertilizer was born in the west to improve crop productivity right there. In contrast to the fact that fertilizer improves crop productivity, it has always been nationally recommended without locally affirmed dose to date. The application of fertilizer has been suffered from ecological fallacy and composition fallacy which deter small-scale agricultural production growth in the country. The fertilizer demand and supply chain analysis also shows that marketing of the product passes through long chains and involves a number of actors that attributes to the late delivery of the product to the end users.

This paper measured chemical fertilizer uptake and use in terms of total fertilizer supplied, percentage of farmers using fertilizer, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare. Except some irregularities, the volume of chemical fertilizer uptake in the district has not been increasing nor decreasing in the last five years. All of the smallholder farmers in the district have been using chemical fertilizer irrespective of the dose of application per hectare. The physical application rate of fertilizer at household level is still below the recommended dose. The current chemical fertilizer application rate is estimated at 51.1 kilogram per hectare of cultivated land while the application of fertilizer for fertilized land under cultivation is estimated at about 77.9 kilogram per hectare of land. Nevertheless, the average physical application of chemical fertilizer per hectare of land is still low compared to the recommended dose. Farmers have been applying fertilizer on Teff and Wheat crop lands only. No other crops have been receiving fertilizer in the area. The current application rate of fertilizer to teff and wheat crops is similar; estimated at about 73.7 kilogram per hectare of land. The trend of carry-over stock and price of fertilizer have got an inverse U shape in the last five years signifying the strong correlation between carryover stock and price of the product. The challenges of agricultural transformation are multidimensional and beyond the scope of this paper to delve and hence the paper pinpointed weak fertilizer demand estimation system, long fertilizer supply chain and late delivery, absence of agricultural input supply subsidies and access to credit, limited alternatives and package of fertilizer, and poor institutional arrangements and professional incentives as the main challenges of fertilizer use in the district.

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