



Crop Diversification and Specialization: Drivers, Impacts on Climate Change Mitigation and Food Security of Small Holder Farmers in Ethiopia

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Abstract:

Crop diversification and among smallholders is incompatible with maintaining or improving household food security specifically when cash crops (specialization) are included in the new crop mix. To address this problem, review the effects of crop diversification and specialization on climate change and food security of the small holder farmers. A lot of findings suggested that crop specialization has significant negative effect on the food security, climate change mitigation and environmental maintenance of smallholder farmers, while the few findings concluded that it has positive effect due to mechanization and commercialization or market orientation which targets on high value crops while the crop diversification positive effect on food security, climate change mitigation and economic benefit of the small holder farmers Reports included preconditions for choice of production systems like the availability of farm size, agro ecology, climatic condition, food security status and overall economy the farmers. Thus, extension approach should have to consider those preconditions to indicate appropriate crop production system whether Crop specialization and Diversification is very important to the particular area, to improve food security of smallholder farmers and to mitigate the climate change.

Keywords: Crop specialization, Crop diversification, Food security, Smallholder farmer

INTRODUCTION

Agriculture plays a critical role in livelihoods, employment, income growth, food security, poverty alleviation, socio-economic development and environmental sustainability in developing countries (IFPRI, 2005; World Bank, 2008). In Ethiopia, about 80% of the population lives in rural areas and depend on agricultural activities (GoE, 2011). This indicates the significance of the sector for the employment and food security of rural people and the country at large. The smallholder farms accounted for about 96% of the total cultivated area while the rest was cultivated by large commercial farms and in terms of output the smallholder accounts for 95% of total agricultural production in Ethiopia (MoANR, 2016). In Ethiopia agricultural production and productivity were low due to; insufficient and erratic rainfall, land degradation, low input application, rapid population growth and market (Zelleke *et al.*, 2010). One rational and cost-effective method may be the implementation of increased agricultural production and productivity was crop diversification. Diversification is change in product (or enterprise) choice and input use decisions based on market forces and the principles of profit maximization (Pingali and Rosegrant, 1995). Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value added crops with complementary marketing opportunities (Clements *et al.*, 2011). Crop Specialization focuses on few crops and practices considered best suited to a certain agro-ecological zone and Market oriented (Stellmacher and Kelboro, 2019). Then the crop production

system is diverted from diversification into specialization. But so many researches assured the advantage of crop diversification over specializations. Food and Agriculture Organization (FAO) policy supports crop diversification with the understanding that it may be an effective strategy for food and nutrition security, employment generation, sustainable agricultural development, environmental and ecological management, and poverty alleviation (FAO,2012). Similarly, recent Inter-national Food Policy Research Institute (IFPRI) publications have argued that growth in agricultural incomes will require diversification by farming households (Tadesse *et al.*, 2011).

Improving income and food security requires articulation of policies that encourage and support subsistence farmers to produce over and above their own needs and use their natural and human resources for high value crops that can easily be sold in the market (Niehof, 2004). From a narrow point of view, agricultural diversification implies increasing the variety of agricultural commodities produced at the farm level and is the response of subsistence farmers to reduce risks (Goletti, 1999).

Food security status of households is predominantly increased by total cultivated land and mainly decreased by land allocated to staples (Degye *et al.*, 2012). According to FAO (1996), food security is assumed to exist “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” commercial activities; and diversification from agriculture into nonfarm activities (Niehof, 2004). In crop diversification, daily calorie intake and dietary diversity also increased (Degye *et al.*, 2012).

Different findings reported that crop diversification and specialization have their own advantage and disadvantage on crop production and food security. Crop diversification and Specialization have their own advantage and disadvantage on the smallholder farmers in Ethiopia Still now the issue of crop specialization and diversification is doubtful agenda for tackling food insecurity problem, particularly for small household farmers in Ethiopia. Even though both of the production systems have their own advantage in different aspects, the selections of appropriate production system vary depending on the land availability, topography of farm land, and agro-ecology. Because of contradicting the conclusion and recommendation on the Impacts of Crop diversification and Specialization of the production system, therefore this paper aimed to briefly highlight the impact of crop diversification and specialization on food security and Climate change mitigation

CROP DIVERSIFICATION AND SPECIALIZATION DEFINITION

Definition Crop Diversification

Crop diversification, which involves the cultivation of more than one crop including both food and cash crops, will also positively affect food security. Farmers who engage in crop diversification will improve their income through the sales of cash crops and food security through own consumption and purchased food crops using the income generated from the cash crop sales (Appiah-T *et al.* 2022). Crop diversification, be defined as an attempt to promote crop diversity by crop rotation, multiple cropping, or intercropping, with the goal of improving productivity, sustainability, and supply of ecological systems (Wezel A *et al* 2014) It could be one step toward more sustainable production systems, value chains for minor crops (Meynard JM *et al* 2018) and socioeconomic benefits. Enhanced agricultural diversity, better diverse crop rotations, mixed cropping cultivation of grain legumes in generally cereal-dominated systems, perennial leys or grassland

(Haughey, E *et al.*, 2018), and regionally adapted varieties or variety combinations are all examples of agricultural diversification strategies.

In developing countries, crop diversification is defined as the substitution of one or more agricultural products for another. Diversification in agriculture can be defined as the reinvestment of some farm productive resources, such as land, capital, farm equipment, and labour, into new enterprises (Anamika Barman *et al.* 2022) A shift from less profitable cropping system to more profitable cropping system is also known as diversification. Diversification of agriculture, in general, refers to transitioning from a single crop's regional or temporal dominance to the production of a variety of crops in order to meet the ever-increasing need for cereals, pulses, oilseeds, fibers, fuel, and feed. Crop diversification is a demand-driven, need-based situation specific and national goal seeking dynamic and iterative concept that incorporates spatial, temporal, value addition, and resource-complementary techniques, as well as a move from traditional and less-remunerative crops.

Definition of Crop Specialization

Crop Specialization focuses on few crops and practices considered best suited to a certain agro-ecological zone (Stellmacher and Kelboro, 2019). Market oriented production enforces the producers to produce the only marketable product. Then the crop production system is diverted from diversification into specialization. But so many researches assured the advantage of crop diversification over specializations. Food and Agriculture Organization (FAO) policy supports crop diversification with the understanding that it may be an effective strategy for dealing with issues as varied as food and nutrition security, employment generation, sustainable agricultural development, environmental and ecological management, and poverty alleviation (FAO, 2012). Similarly, recent International Food Policy Research Institute (IFPRI) publications have argued that growth in agricultural incomes will require diversification by farming households (Tadesse *et al.*, 2011).

CROP DIVERSIFICATION AND SPECIALIZATION DRIVERS

Policy and Market Driver

Increased household income in most cases leads to improved resilience, especially against market, climate shocks, and better nutritional outcomes. Both on-farm diversification and specialization can contribute to more diverse and stable earnings; yet, they are dependent on access to functioning markets where surplus crops can be sold for profit. Access to markets, in turn, enables households to choose from a larger variety of foods and thus to diversify their consumption further. Specialization focuses on few crops and practices considered best suited to a certain agro-ecological zone, Market oriented production enforces the producers to produce the only marketable product this production system is diverted from diversification into specialization. Market information affects the level of diversification positively and significantly. According to Rehima *et al.* (2015) reports Households who had access to market information increased their level of diversification by 39.43%. This implies that market information may decrease the uncertainty of the households associated with crop diversification. The findings of this study are consistent with other studies that reported that market information affected positively the diversification of paddy to vegetables in Thailand and crop diversification in Ethiopia (Pitipunya, 1995; 2011; Rehima *et al.*, 2013). Access to market information significantly affects crop diversification at 10% probability level (Wondimagegn *et al.*, 2011). Households having access to market information are more likely to diversify their production since they have the information related to supply, demand and prices of most crops. It is evident from the result

that households who own farm machinery (water pump) are more likely to diversify because they can properly perform different farming operations on time and can market their produce easily. The variable is significant at 5% probability level and the result is consistent with the finding of Muhammed *et al.* (2008). Owning machinery (water pump) is related to an increase in probability of crop diversification by 0.29% and the intensity by 3.85% on average (Wondimagegn *et al.*, 2011).

The most common market interventions are food reserve purchases and agricultural input support programs most often in the form of subsidies which incentivize the production of a few staple crops (Gebremedhin and Jaleta 2012) On the other hand, when infrastructure is poor and markets imperfect or missing farmers tend to diversify to better manage their risks and to ensure basic food security (Mofya-Mukuka and Hichaambwa 2016). The provision of services such as energy, extension, water, and credit can also influence production decisions (World Bank 2008).

Policies and institutions can influence farmers' decisions through different measures, such as subsidies, taxes, agricultural support schemes, investments in research and rural training programme. The effect of agricultural extension services on the adoption of diversified farming systems was the most studied variable within the policy and institutional context. Agricultural trainings are not only a source technical knowledge and skills, but can promote and create awareness about the potential benefits of diversification and the adoption of new varieties Moreover, rural extension can be a channel to access new planting material (Williams *et al.* 2018) and a source of updated information about market opportunities, new technologies, climate change and risk management strategies (McCord *et al.* 2015)

Environmental Drivers

Agroecological zones, climate, natural resources, the prevalence of pests or diseases and shocks are key environmental drivers of agricultural production decisions in SSA, Farmers tend to focus on one crop which is adjusted to the agro-climatic condition. For example, tea, wheat, oats, and barley are grown in cool, wet areas, and rice in valleys of hot and wet regions such as swamps and marshlands. The Long growing season, Poor environmental conditions and soils Climate shocks and other agricultural risks was the positive impact on the crop diversification and Negative Impact on the crop specialization (Heumesser, C., & Kray, H.)

Topographic features, such as altitude and slope, affect other environmental characteristics like temperatures, soil erosion, wind and solar radiation exposure, but also the accessibility to farms and roads. According to Fan *et al.* (2019); Rayol *et al.* (2019), study the topography had significant association with the crop diversity (farmland slope may drive diversification, as uneven conditions of agricultural land require the farmers to adapt by growing the appropriate crop combination for each area (Abebe *et al.* 2013; Schroth and Ruf 2014). This is one of the cases in which diversification becomes more a necessity than a choice.

According to Rehima *et al.* 2015 findings reveal that land size affected crop diversification decision of the households positively and significantly as well as increase in the area of cultivated land by one hectare increases the probability of diversification by 15.82%. This implies that large farm sizes may enable households to allot their land to multiple cereal crops than smaller holdings. Previous studies indicated that land size positively affected crop and variety diversification (Benin *et al.*, 2004).

Socio Economic Drivers on Crop Diversity and Specialization

Socio-economic drivers are defined as aspects or features that typify a group of people in a community or society that constrain or facilitate the productive diversification at the household level; institutional drivers are constructions or arrangement that exists in a society that may either constrain or facilitate productive diversification. Examples of socio-economic drivers include, among others, the level of education, gender, market access, status and income, and knowledge about the nutritional value of foods. Examples of institutional drivers include, among others, the rules, norms, and routines that guide the behavior of people in a society or in a community, as well as the distribution of power in decision-making

ROLE OF CROP DIVERSIFICATION AND SPECIFICATION ON THE CLIMATE CHANGE RESILIENCE

In an effort to adapt the risky environment, smallholders make certain production decisions and employ various risk mitigating strategies. Crop diversification is one method of reducing; the climate adaptation programmes (Isabel López *et al.* 2017). In particular, crop diversification results showed that the farmers use of diversification strategies was more frequent in flood prone areas (Mandal and Bezbaruah 2013), subjected to a strong incidence of droughts (Asfaw *et al.* 2018), previous extreme weather events or shocks (Huang *et al.* 2014; Nguyen *et al.* 2017; Tesfaye and Tirivayi 2020). Several studies report that the crop diversification can mitigate the global climate change (Labeyrie *et al.*, 2021).

Crop switching and diversification have been presented among key climate change adaptation strategies (Beyer *et al.*, 2022; Rising & Devineni, 2020). However, the potential for transforming or maintaining diversified agricultural systems depends on the ability of the 'new' or added crops to complete their cycle with reasonable production outcomes in the targeted areas which is referred to as their suitability (Sloat *et al.*, 2020). Diversifying cropping systems is a transformational adaptation strategy required for areas where climate change impacts are projected to be severe that stabilizing yields under a changing climate is not feasible (Rippke *et al.*, 2016). Farming households in Sub-Saharan Africa are often exposed to significant risk of climate-related shocks due to the crop Specification rather than the crop diversification. Due to the large reliance on rain fed agriculture among rural farming households in Sub-Saharan Africa, their livelihoods are highly vulnerable to weather-related risks and climate change (Adhikari *et al.* 2015). Climate change is a particularly pertinent threat that is exposing African agriculture to various forms of risks, ranging from weather variability, increased frequency and severity of droughts and floods, changes in the occurrence and range of crop and livestock pests and diseases, or greater price volatility in output, input and factor markets. The direct impact of climate risks includes a drop in agricultural production (crops and livestock), while indirect effects may entail a decreasing demand for labor and increased local prices for inputs and the product itself (Thornton and Lipper 2013). According to Reardon *et al.* (2000) report to minimize the climate cause risk the crop diversification was the most practical. Freeman *et al.* (2014) indicated that specialization may pay-off in highly variable environments if a subsidy is derived from an alternative stream of resources that can act as insurance to mitigate the risk associated with high production variance. Individuals may adopt technologies, such as irrigation, that improve the availability and predictability of water for crops. Such technology could make specialization worthwhile in environments that otherwise impose severe costs on specialization and exchange. According to Wolf (1982), specialization may still prove beneficial to individuals or individuals may be coerced to specialize, even in highly uncertain environments.

EFFECT OF CROP DIVERSIFICATION AND SPECIALIZATION ON THE FOOD SECURITY OF SMALL HOLDING FARMERS

Crop diversification, which involves the cultivation of more than one crop including both food and cash crops, will also positively affect food security. Farmers who engage in crop diversification will improve their income through the sales of cash crops and food security through own consumption and purchased food crops using the income generated from the cash crop sales (Appiah-T *et al.* 2022)

Effects of crop production diversification on nutritional intake of farmers based on the data of 3,000 households in Malawi from 2010 to 2013, and the results indicated that the improvement of crop production diversification could significantly increase farmers' intake levels of energy, protein, iron, vitamin A and zinc (Jones 2017). The World Bank (2018) further pointed out that diversified production strategies can protect agricultural production systems from the impacts of climate and market changes, and improve farmers' intake of nutrients such as protein, vitamins and minerals to enhance their nutritional health. However, Mukherjee (2015) analyzed the relationship between crop production diversification and the per capita intake of energy, protein, fat and other nutrients of farmers based on the survey data of 6 villages in 3 districts of West Bengal in India, and found that the diversification of crop production has a negative correlation with the per capita intake of energy, protein and fat in each region (Yang *et al.* 1993). Crop production specialization has a significant negative impact on farmers' energy and fat intake after overcoming the endogenous problem of the model, which implies that from the perspective of nutritional intake, crop production specialization is not conducive to improving farmers' livelihood and welfare (Sun F, *et al.* 2022)

In addition, crop diversification was found to have a positive and statistically significant impact on food security and nutrition indicators (food consumption score and household dietary diversity). This implies that besides improving productivity, increasing production and income stability, crop diversification also has a direct effect on food availability and nutrition. This is mainly because crop diversification will improve yields, bring crop yield stability and also that crop insurance effect (Mugendi Njeru 2013; Yachi and Loreau 1999), since if one crop fails the farmer can depend on the other crop. This will have a direct impact on food security and nutrition in smallholder farming systems since traditionally the main aim will be to sustain the family and selling surplus where possible. This makes crop diversification a more important climate smart option as improving food security and diet options will help in building resilience to intensifying climate change and variability effects by smallholder farmers. According to Mugendi Njeru (2013) crop diversification not only allows more efficient utilization of agro ecological processes, but also provides diversity for human diet and improve income which improves the purchasing power for the household for buying other foods. In contrast to the FAO and IFPRI finding reports, other studies neglect the importance of crop diversification over specialization for food security. Qin and Zhang (2016) observed that households in China which specialize in crop production are less poor. Similarly, Qin and Zhang (2016), reported that households to specialize in high-value crops for sale to markets. Cultivation and sale of high-value crops to high-income is aim of crop specialization. Mansanjala (2006) identified pathways through which cash crop specialization can lead to poverty alleviation. In cash cropping specialization was very important for the markets, to contribute to the development of rural financial markets through relaxed credit constraints to improve agricultural technology and may be positively associated with increased productivity in other household activities. In contrast to this, Birthal *et al.* (2015), reported use the concept of diversification as cultivation of high-value crops in India. Contrarily, Degye *et al.* (2012) reported

that crop diversification is not correlated with status of food security indicators suggesting that households' effort to diversify in their crop production pattern.

SUMMARY AND CONCLUSION

The crop diversification and Specialization problem of any society in any country directly correlated with their food production system. In case of Ethiopia is also not away from the above truth. Due to inconsistency crop production systems and agricultural policy of the country, food insecurity has been deep rooted problem which needs solidarity to tackle particularly for small household farmers. In view of these facts, this review paper aimed with the impact of crop Diversification and specialization on climate change mitigation and food security of small household farmers in Ethiopia. A lot of findings suggested that crop specialization has significant negative effect on the climate change mitigation and food security of smallholder farmers, while the few findings concluded it has positive effect due to mechanization and commercialization or market orientation which targets on high value crops. Reports included preconditions for choice of production systems like the availability of farm size, agro ecology, climatic condition, food security status of overall economy the farmers. Crop diversification is positive effect on the greater diversity of crop and animal genetic resources and soil biota on the farm and across the wider agro-ecosystem. Biodiversity increases the resilience of agro-ecosystems to climate-related stressors and shocks by providing a variety of traits such as drought- or cold-tolerance, and by generating key ecosystem services such as nutrient cycling, soil carbon sequestration, or biological pest and disease control, among others Thus, extension approach and policy makers should have to consider those preconditions to indicate appropriate crop production system in a particular area, to improve the productivity of crop through diversification for food security of smallholder farmers and climate change mitigation

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