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Adoption and Impact of Exotic Poultry Farming on Livelihood of Smallholder Farmers: the Case of Dera District, Amhara Region, Ethiopia

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BAHIR DAR UNIVERSITY

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCE GRADUATE PROGRAM

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M.Sc Thesis

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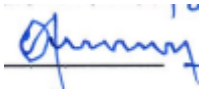
Kassahun Tassie		July 22, 2024
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I, Mulugeta Tsegaye Gebremariam, declare that this thesis is my original work and has not been presented for the award of a degree or any other award in any other university.

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Supervisor's Declaration

I confirm that the work was carried out by the candidate under my supervision as the official University supervisor.

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ABSTRACT

Poultry production plays an important role in the human economy, supplying food, creating wealth through job creation for the booming population. In the study area (South Gonder zone of Amhara region), livestock, and fishery department disseminated various chicken breeds solely and in collaboration with different projects. Dera is one amongst the poultry producing districts in South Gonder Zone. However, the status of exotic poultry breeds distributed and disseminated towards the rural farmers by the nearby institutions and the impact of exotic poultry breeds adoption in enhancing livelihood outcomes on farmer households not adequately studied in Dera district. This study aimed at analyzing the factors that affect adoption decision and the intensity of adopting exotic poultry breeds at household level; and to evaluate the impact of exotic poultry breeds adoption on households' livelihood in Dera district. Data was collected through interviews from a sample of 189 households' selected using multi-stage sampling. A double hurdle model was used to analyze the level and intensity of adoption of exotic poultry breeds. The results showed that family size, participation in cooperatives, livestock holding, extension services, farm size, off farm activity and experience of rearing poultry influenced the decision to adopt exotic poultry breeds positively whereas distance to the nearest market has negative significant influence. The intensity of adopting exotic poultry technology, on the other hand influenced positively and significantly by household marital status, annual income gained from exotic poultry production and experience of poultry keeping whereas annual expenditure for exotic poultry production and sex of the household head influenced negatively and significantly intensity of adoption. Endogenous Switching Regression (ESR) approach was used to analyze the impact of adopting exotic poultry on household farmers' livelihood. Results showed that the households that adopt exotic poultry breeds annual income would decline by 5465.48 ETB had they decided not to adopt. In the counterfactual case, the annual income would have increased by 3008.63 ETB amount had they decided to adopt the improved breed significant at 1% level of significance. Similarly, the consumption expenditure would have declined by 5985.48 ETB for adopting households had they decided not to adopt exotic poultry breed. In counterfactual, households that did not adopt the breed would gain 2520.22 ETB to cover their consumption expenditure had they decided to adopt exotic poultry breeds. From the Full Information Maximum likelihood ESR –based treatment effect, results revealed that adoption

of exotic poultry breeds had positive income and consumption expenditure impact on both adopters and non-adopters of the technologies. That means as the farmers adopt and practice the exotic poultry breeds, their lives in case of cash income and consumption expenditure improved indicating positive impact of exotic poultry breeds adoption on the livelihood of smallholder farmers. Thus, the impact of exotic poultry breed technology on the welfare of smallholder farmers was higher compared to those local chicken keepers. More programs targeting women should be designed and supported by both the higher and district level decision makers. Poultry production is an enterprise that is more important for and associated with women as compared to men. Hence, due attention should be given to female farmers to economically empower them.

Key Words: *Adoption, Double hurdle, Exotic breed, ESR, impact, Dera Woreda, Ethiopia*

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LIST OF ABREVATIONS AND ACRONYMS

ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
BB	Bovans Brown
CF	Conceptual Framework
CSA	Central Statistical Agency
DAs	Development Agents
Dos	Day-Old-Chicks
DWAO	Dera Woreda Africultural Office
DWLFO	Dera Woreda Livestock and Fishery Office
ESR	Endogenous Switching Regression
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FIMLE	Full Information Maximum Likelihood Estimation
GDP	Gross Domestic Product
GO	Government Organization
HHs	Households
IC	Improved Chicken
KII	Key Informant Interview
LFO	Livestock and Fishery Office
LR	Likelihood Ratio
MoA	Ministry of Agriculture
NGO	Non-Governmetal Organization
PPS	Probability Proportion to Size
PSM	Propensity Score Matching
RIR	Rhode Island Red
SNNP	Southern Nations Nationalities and Peoples' Region
TLU	Tropical Livestock Unit

USAID	United States Agency for International Development
VIF	Variance Inflation Factor

1. INTRODUCTION

1.1. Background and Justification

Poultry production plays an important role in the human economy, supplying food, creating wealth through job creation for the booming population. The nutritional benefits derived from poultry products include animal proteins, minerals, fat-soluble vitamins, carbohydrates; pigments, fluids, and cholesterol are attributable to its relevance as the world major source of food. Moreover, It is a suitable business for poor households due to the small quantity of land needed and the low investment costs required to start up and run the operation. It is also relevant for industrial uses in the supply of vaccines, fertilizers, animal feed, pharmaceuticals, including preservatives during semen storage, in paint and adhesives, varnishes and printing ink. (Tadelle et al., 2003; Dilger et al., 2016; Ahmed, 2018; 2019; FAO, 2019; Ugbe et al., 2020).

Poverty reduction and food security improvement in sub-Saharan Africa have been the major national and international development issues. The agricultural sector contributes a lion's share to food and nutrition security, as well as economic growth in many developing countries, and takes up 65% of the employment force and 32% of gross domestic product in Sub- Sahara Africa (Fuglie K. 2018). Well-developed and introduced agricultural technologies play an important role in increasing agricultural production and productivity, smallholder farm household income thereby to achieve food security, and in reducing poverty (Asfaw s. et al.,2012; Bekele S. et al., 2014; Tesfaye Z. et al., 2016; Jaleta M. et al., 2018; Misgana M., 2018). Agriculture is a basis for the entire socioeconomic structure of the country and has a major influence on all other economic sectors and development processes and hence, plays a crucial role in poverty reduction in Ethiopia. Even if the share of agriculture to GDP is reduced recently, it has still largest contributions that are 35% to the total country GDP, 73% to employment, and 90% to foreign exchange earnings. Moreover, the livelihood of about 90% of the poor is fully or partly dependent on agriculture as a result of which, agricultural development will continue to be the basis for economic growth and development. (CSA, 2021).

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020 (CSA, 2020a). The

sector contributed up to 40% of agricultural Gross Domestic Product (GDP), nearly 20% of total GDP, and 20% of national foreign exchange earnings in 2017 (World Bank, 2017).

Poultry is one of the most important agricultural subsectors for rural communities in Ethiopia and poultry population is almost entirely composed of indigenous chicken and recent estimates showed that 81.7%, 10.9%, and 7.4% are indigenous, hybrids and exotic poultry, respectively (CSA 2020a).Ethiopia has large poultry population, estimated to be 57.01 million preceded by cattle, 70.29 (CSA, 2021). About 78.85% of the Ethiopian poultry population consists of indigenous chickens, while the remaining 21.15% consists of exotic and hybrid breeds of chickens. The total number of poultry at country level estimated at around 57 million. Poultry production system in Ethiopia is indigenous and an integral part of farming system; predominantly prevailing in the country and it is characterized by small flock, minimal input and unorganized marketing system (FAO, 2019b). The poultry population is almost entirely composed of indigenous chickens. Oromia region has largest number of poultry population followed by Amhara, South Nation and Nationality People of Ethiopia (SNNP) and Tigray region. As aresult Oromia, Amhara and South Nation and Nationality People of Ethiopia regions has about 33.62%, 33.44%, 16.91%, and 12.28% of the total poultry population of the country, respectively (CSA 2021).

The poultry sector indeed dominated by the indigenous breed, extensive scavenging, and small scavenging family poultry production systems (FAO, 2019; CSA 2020). Accordingly, chickens widely distributed in almost all over part of the country and reared by rural family to enhance the productivity in terms of egg and meat in the study area. Despite all this efforts, still Ethiopian poultry consisting of mainly local birds and with regard to breed, 78.85%, 12.03% % and 9.11% of the total poultry are local, crossbred and exotic, respectively (CSA, 2021). Despite composing just 9% of the bird population, imported breeds account for 27% of the egg production (FAO. 2019).

Market prices of chicken in Ethiopia are seasonal. Consumer prices generally rise during holidays such as Easter, New Year, and Christmas. The demand of poultry meat demand increases during the time of holidays Ethiopian Christmas of 2021, that is indigenous breed (1000 ETB), Exotic breed (450 ETB) and Crossbreed was 700 ETB (Dugassa G., 2022)

To increase the chicken contribution to income and dietary diversity of the household; ministry of agriculture and rural development of the country have been multiplied and disseminated several exotic chicken breeds to the farmers over the last 50 years in different parts of the country (Demeke, 2008; Molla et al., 2010; Hinsemu et.al., 2018).

In the study area (South Gonder zone of Amhara region), livestock and fishery department disseminated various chicken breeds solely and in collaboration with different projects. Dera is one amongst the poultry producing districts in South Gonder Zone. However, there is tight empirical evidence on the probability and intensity of exotic poultry adoption and till the author's knowledge, there is no tangible information that revealed the impact of adopting exotic poultry breeds on smallholder farmers' livelihood in Dera. Thus, this study aimed at analyzing the factors that affect adoption decision and the intensity of adopting exotic poultry breeds at household level; and to evaluate the impact of exotic poultry breeds adoption on households' livelihood in Dera district.

Most previous researchers in the study area employed Double-hurdle model to identify determinant factors influencing adoption decision and intensity of adopting the technology. Propensity Score Matching (PSM) method to evaluate the impact of adopting it, but the results from propensity score matching could not show the real adoption impact of agricultural technologies because the analytical tool failed to account self-selection arise from unobserved endogeneity problem (Khandker S.R., 2010).

Furthermore, this study contributes to the existing literature by providing empirical evidence on two important aspects. First, factors influencing adoption decision and intensity of adopting exotic poultry chicken using double-hurdle model. Second, the impact of exotic poultry adoption on smallholder farmers' welfare by taking in to account selection biased stemmed from both observed and unobserved heterogeneity using endogenous switching regression (ESR) to generate a consistent and unbiased estimate on income and expenditure dimension of the households' livelihood. Hence, to inform future research and policy better, this work attempts to assess the factors affecting adoption decision and the intensity of adopting exotic poultry breeds at household level using Double-hurdle model; and to evaluate the impact of exotic poultry breeds adoption on households' annual income and annual consumption expenditure using Endogenous Switching Regression (ESR) Model.

1.2. Statement of the problem

Poultry farming in Ethiopia represents a significant part of the national economy in general and the rural economy in particular and contributes to 98.5% and 99.2% of the national egg and chicken meat production, respectively (Kefyalew and Tilahun, 2017).

In the study area (South Gonder zone of Amhara region), livestock, and fishery department disseminated various chicken breeds solely and in collaboration with different projects. Dera is amongst the poultry producing districts in South Gonder Zone. However, the status of exotic poultry breeds distributed and disseminated towards the rural farmers by the nearby institutions and the impact of exotic poultry breeds in enhancing livelihood outcomes on smallholder farm households had not adequately studied in Dera district.

Therefore, the current study aimed at filling this existing knowledge gap. The results would help smallholder farmers in decision making on adoption of improved technologies, as they aim to improve and expand on their stocks.

1.3. Objectives of the Study

1.3.1. General objective

The general objective of the research was analyzing adoption and impact of exotic poultry farming on livelihood of smallholder farmers in dera district.

1.3.2. Specific objectives

1. To examine factors determining the probability and intensity of exotic chickens adoption among rural producers in the study area
2. To examine the contribution of exotic poultry production to household's annual income and consumption expenditure
3. To evaluate the impact of exotic poultry production on the livelihoods of smallholder farmer households

1.4. Research Questions

This study conducted to identify factors that determine farm households' decision to adopt exotic poultry breeds and its impact on livelihood of smallholder farmers. Accordingly, the study focuses on the following research questions:

1. What are the characteristics (demographic, economic, and institutional) of farmers towards the exotic poultry breeds adoption?
2. What are the factors determining the adoption and intensity of exotic poultry breeds in the study area?
3. What is the impact of exotic poultry breeds adoption on the smallholder producers' income and consumption expenditure?

1.5. Research Hypothesis

1. Smallholder farmers' characteristics (Demographic, economic and institutional) have no significant effect on adoption of exotic chicken in Amhara Region?
2. Exotic chicken has no positive significant impact on livelihood of smallholder farmers in Amhara Region.

1.6. Scope and limitation of the study

This study was carried out in South Gondar Zone, Dera district in 2022/2023 to examine the characteristics of smallholder farmers on exotic poultry adoption, examine the impact of exotic poultry to household income and consumption expenditure, and study factors determining probability and intensity of exotic chickens among rural chicken producers in the study area. In spite of farmers in Dera district engagement in different agricultural technology adoption; however, this study was limited to assessing determinants of exotic poultry adoption and estimating their impact on households' cash income and consumption expenditure. There may be various factors affecting smallholder farmer's adoption decision, but the depth of this study is restricted to household level factors (demographic, socio-economic, and institutional factors).

Furthermore, the intensity of exotic poultry adoption was measured by the ratio of the total number of exotic poultry reared to total number of poultry owned by each household. In terms of population coverage and geography, the study targeted 189 smallholder households from a single selected district and four kebeles. Therefore, this study may not represent the status of smallholder farmer's exotic poultry adoption at zonal, regional, and national level. Due to time and budget constraint, the study was limited to use cross sectional data of 2022/2023 production year, which could be better, explained with panel data.

1.7. Significance of the study

Agro-ecological settings, socioeconomic and cultural characteristics of the farming communities vary from one to another, and the adoption decisions towards a given technology are also varies. Previous studies undertaken in the country on the adoption pattern of exotic poultry breeds and other technological packages are limited to a few areas. Thus, studying the adoption patterns of exotic poultry breeds in Dera district and analyzing factors that determine adoption and its impact on the livelihood of smallholder poultry farmers provide an insight to local decision makers, planners and practitioners in setting priorities for investment resource allocation and the formulation of appropriate rural development programs aimed at increasing farmers' income and it gives an understanding about the quality of food consumed in the households. The study also expected to make its own contribution to the existing body of information in the field of poultry technologies.

1.8. Organization of the Thesis

The thesis organized in to five chapters. The first chapter introduces the background, statement of the problem, the objective, research question as well as the scope and limitation of the study. The theoretical framework, analytical framework, Empirical Studies, and relevant literatures reviewed in the second chapter. The third chapter discusses the research methodology used to undertake the study. Results had presented and discussed in the fourth chapter. Chapter five present summary, conclusion, and recommendations. The last part presents the references and appendixes respectively.

2. LITERATURE REVIEW

2.1. Definition of concepts and Terminologies

Adoption – refers to the decision to use a new technology or a given practice by a farmer at a given period after having full information on the potential of that particular technology (Rogers, 1983).

Exotic Chicken: Imported chicken that are used according to their main production aim as egg laying or meat production (Van Eekeren, 2006).

Household welfare: is defined here as a household's command over market and non-market goods and services at the household level (Tilman Brück.2004.). Welfare was proxide by income, food and none food consumption in the empirical analysis of the study.

Improved Chicken: a domestic fowl, usually either lightweight or black feathers and a fleshy crest on its head, raised for its meat and eggs. A chicken is improved if some genetic improvement is made scientifically for the purpose of specific human interest, such as for meat or egg (Encarta, 2005).

Production technologies – they are ideas or objects perceived as new by farmers in the process of agricultural production which affect the growth of agricultural output (Mahajan and Peterson, 1985).

Poultry - all domestic birds kept for human food (meat and eggs) production including chickens, ducks, ostrich, guinea fowl, doves, and pigeons (Getu, 2014). From poultry species, chicken is the most popular and worldwide in terms of their economic importance (Nigussie, 2011).

Smallholder farmer: defined as those with a low asset base, limited resource endowments, poor resources, low farming technology, fragile market relationships, low access to services, finance, and information relative to commercial farmers (Dixon et al., 2003; World Bank, 2003).

2.2. The Role of Poultry Production in Ethiopia

In most developing countries, for poor households, village chickens play a major role in the improvement of households' food security and poverty alleviation (Adongo, 2004, Moreki et al., 2010). Village poultry provides the owners of the chicken with nutritional and economic benefits with minimal use of inputs or without any inputs. They provide their owners with economic and nutritional benefits with little or no inputs (Reta, 2009; Moreki et al., 2011).

Due to their requirement of small feed, space, low cost and high turnover rates, poultry rearing is an appropriate activity for the poor and their products are great marketable (Mengesha et al., 2008a) and playing significant social and cultural roles in the life of rural people (Kryger et al., 2010). From Ethiopians viewpoint, chicken rearing activity is one of the most suitable activities for rural women, landless and poor farmers and it is a source of income, creates employment opportunities, and increases the supply of high quality animal protein (Tadelle et al., 1999; Simainga et al., 2011; Jerevazio, 2014). Chicken in Ethiopia represents a significant part of the national economy and contributes to the national egg and chicken meat production, respectively (Kefyalew and Tilahun, 2017).

Village chicken, in most part of the country, remarkably contributes to the livelihoods of the rural household as a preliminary point of investment, as a means to recover from disasters (insurance against distresses), as an accessible protein source and for income and exchange purposes, food security, and socio-cultural functions, hospitality and exchange of gifts to support social relations (Tadelle et al., 2003; Aklilu, 2007; Reta, 2009; Jerevazio, 2014).

Eggs are a source of high quality protein for sick and malnourished children under the age of five (Delgado et al., 1998), for women post-birth (Jennifer, 2006). Poultry products are reasonably priced quality animal protein sources for the smallholder households (Alemu et al., 2009; Jerevazio, 2014). In rural areas of Ethiopia, households consume inadequate quantities of chicken meat and eggs because they mainly rear for the purpose of income (Bush, 2006).In addition to income source, very little used for home consumption (Ermias et al., 2015).

The income mainly used to purchase and pay for household needs and for non-expenses such as health care and education is gained from chicken and egg sales (Alders et al., 2003). The market demand and price of a live chickens and eggs experienced during the last years are very much rewarding compared to the previous times indicating that for poor families, poultry are often one of their few sources of petty cash (Bush, 2006). According to the Aklilu et al.

(2007), commercial poultry is highly dependent on market for inputs, the owners are wealthy by the Ethiopian standard and kept at a full time business. The small scale modern poultry farms could either be kept as supplement to family income or as a full time business.

Village chicken is also the only capital that households have left when declining into poverty because of varies reasons such as drought (Aklilu, 2007; Meseret, 2010).

Paweł (2005) reported that consumption of poultry and fish has not been found to be associated with increased risk of cancers. Costa (2009) described the attributes of chicken meat to its intensively based and vertically integrated operation. Arrey (2009) reported also that the possibility of village poultry as a viable sector to boost protein deficiencies. To improve chicken production and to satisfy the demands of protein foods, participation of family members in the household is highly required in the phenomena of poultry productions. Furthermore , FAO (2010) reported that Chicken meat is relatively healthier than others; containing low total fat and it has high desirable monounsaturated fats. The human population benefits greatly from poultry meat and eggs, which provide food containing high-quality protein, and a low level of fat with a desirable fatty acid profile.

2.3. Ethiopian improved chicken population and distribution

Four breeds of exotic chicken (Rhode Island Red, Australop, New Hampshire, and White Leghorns) were imported to Jimma and Alemaya universities in 1953 and 1956, respectively under the USAID project (Demeke, 2008). Even if there is no evidence indicating the exact time and locations of the introduction of the first batch of improved breeds of chickens into Ethiopia, it was believed that the improved breeds of chickens were introduced by the missionaries sometime in the mid decades of the last century (Molla, 2010).

2.4. Types of preferred improved chicken in Ethiopia

Ermias et al. (2015) researched the characterization of husbandry practices, adoption, and impact of village poultry technology packages in the central Oromiya Region, Ethiopia. In their study, they found BB chicken breed adoption was higher than other chicken breeds by smallholder farmers.

A survey conducted by Getiso et al.,(2017), to identify traits of preference mainly on egg production, body size and meat production, scavenging ability, disease resistance, and physical appearance of Bovans brown (BB) chickens breed under village production system

in three agro-ecologies of Southern Nations, Nationalities, and the Peoples Regional State of Ethiopia they concluded under their research that, 94.4% of respondents on average in all agro-ecologies select bovans brown for egg production.

Bovans Brown (BB) breed was formerly known as Bovans Goldline and is a hybrid of Rhode Island Red (cock) and Light Sussex (a hen). It is the bird of choice for today's egg farmers who expect high egg numbers and a forgiving bird essential ingredient to keeping business profitable. It not only performs well for the egg producer with traditional production facilities but is very docile making it's the perfect bird for alternative production methods as well (Hinsemu et.al, 2018).

Like Bovans Brown, Issa Brown is also available in Ethiopia. This layer is a hybrid of Rhode Island Red (a hen) and Rhode Island White cock. It is known for its high egg production of approximately 300 eggs per hen in the first year of lying. They are easy to rise and prolific producers of large richly colored brown eggs of excellent shell quality. They are quiet and friendly and easily trained to lay in their nest (Hinsemu et.al, 2018).

White Leghorns are known for laying many white eggs. They need less feed, due to their small size. White Leghorns are therefore Very efficient layers. At the end of the laying period, they give relatively little meat (Haftu, 2016).

2.5. Empirical Studies

Empirical studies are helpful for the purpose of predicting which people could be expected to adopt technologies quickly or slowly than others. It is expected, at the same time, that such information would help to design more effective communicative interventions Leeuis and van den Ban, 2004). There are different sets of factors behind the decision to adopt a given technology (Teklewold et al., 2006). Therefore, it is very appropriate and necessary to pay serious attention to the factors that facilitate or hamper the process (Aregay, 1980).

Distance to the training center, off-farm activities, improved indigenous chicken, the gender of household head, farm size and group membership awareness significantly affected the adoption decision of improved indigenous chicken in Makueni and Kakamega counties using a double hurdle model and PSM (Kamau, Kabuage and Bett, 2017).

Participation decision of IC producers was found to be constrained by the household head, household size, distance to market, membership to farmers group, demand price, flock size among smallholder farmers in Busia County using both inferential, descriptive and multi variant statistics (Mirembe, 2018).

The household size, level of education, extension services, family size, breed type and number of poultry owned were found to significantly influence poultry producers' participation decision in Kaffa of Southern Ethiopia using both descriptive and probit regression model (Tarekegn and Yosefe, 2017).

Ermias et al. (2015) hypothesized that sex, age, farm size, land holding, farm experience, technology experience, access to extension service, training and distance to market affects poultry technology adoption using Double Hurdle model.

A study conducted by Wondemeneh et al. (2015), easiness to manage, input availability, education, gender, age, credit access, farm size, off-farm income, social contacts, extension visit, livestock income and training were identified that influence probability and intensity of adoption of exotic chickens using Heckman selection two-step model. The finding of the study revealed that having a large farm size and income that generated from livestock holding apart from poultry negatively affects the adoption of exotic poultry.

Sex of the household head, family size, availability of supplementary feeding, credit and extension services were found to influence the rate and intensity of adoption of poultry technology in East Shewa and Welayeta in Ethiopia, using double-hurdle class of model (Kassie, Teklewold, Jaleta, Marenya & Erenstein, 2015).

The adoption of poultry technology in the highlands of Ethiopia indicated that adoption has been limited by a set of factors such as lack of knowledge on chicken husbandry (feeding, housing, health care.), lack of complementary inputs (feed, alternative breeds), environmental changes and high susceptibility of chicken, lack of strong extension follow up and high disease prevalence using Double Hurdle Model (Tamir et al., 2015).

The results finding by Dehinenet et al. (2014a) revealed that family size, farming experience, availability of dairy production extension services, availability of cross breed cows, accessibility of saving institutions, total income from milk and milk products, availability of

training on livestock, age of household head and off-farm activity participation played significant roles on both the probability of dairy technology adoption and its level of adoption using Double Hurdle model.

Access to extension services, gender, education level, membership to farmers' groups and off-farm income were found to significantly influence the adoption of management interventions in indigenous chicken production in Western Kenya, using a multinomial logit model (Lestari, Natsir, Sirajuddin, Kasim, Ali, Saadah & Mawardi, 2012).

Farm size, expected benefits from technology adoption, access to credit and extension services, significantly influence technology adoption decision of farm households in Ghana using binary logit model (Akudugu, Kwesi and Dadzie, 2012).

A study by Mailu, Wachira and Munyasi (2012) evaluated the probability of participation decisions of poultry farmers in the former Eastern Province of Kenya, by employing a binary logistic regression model. The results suggest that while farmers complain of poor farm gate prices for indigenous chicken offered by intermediaries, volumes of sale are also an important drawback to market participation.

Likewise, Endrias (2003) reported that education, gender, labor availability, farm experience, involvement in off-farm activities, farm size, distance to market and access to extension hypothesized to affect probability and intensity of agricultural technology adoption using Double Hurdle model. The finding of the study revealed that farm experience and access to extension service positively and significantly affects the probability and intensity of agricultural technology adoption whereas, distance to market and off-farm activities negatively and significantly affects the probability and intensity of agricultural technology adoption.

According to Ebojei et al. (2012), farmers who have frequent contacts with extension agents had a higher probability of participation in the innovation using logistic model. For example, extension contact positively influenced exotic chicken breed adoption in Ethiopia (Teklewold et al., 2006a) using Double Hurdle model.

Similarly, the study conducted by Jebessa (2008), age square, gender, education level, total family size, total number of livestock, total farm size, experience of providing supplementary feed, off-farm activities, output taste of the poultry, disease resistance of the poultry, access to credit service, access to extension services, leadership position, distance from the nearest market, homestead utilization and experience of poultry adoption affects probability and intensity of poultry adoption. The finding of the study revealed that being in the leadership position, livestock holding, experience of providing supplementary feed, access to credit service and access to extension services positively and significantly affects probability and intensity of poultry adoption.

Similarly, among institutional factors, access to credit, which seems to be an important factor to adopt a given technology, but the findings of Fisseha et al. (2015), indicated insignificant for adoption of improved poultry breeds.

The result of the different empirical studies shows little agreement, suggesting that the adoption decision and extent of adoption of agricultural technologies are influenced by a number of interlinked and interacting sets of socio-economic, biophysical, technological, institutional and demographic factors as well as characteristics of the farmers' operational environment.

Scholars at home and abroad have also carried out a lot of research on the farmer's income effect of agricultural technology.

The study conducted by Ma and Abdulai (2019) show that the adoption of IPM technology can significantly increase apple production, net income, and agricultural income using PSM.

Gao et al (2019) evaluated the farmer's income effect of agricultural technology using an endogenous switching regression model and a multinomial treatment effects model. The result shows that the adoption of green control techniques has a significant impact on the increase of farmer's agricultural income.

Etsehiwot and Solomon (2020) examine factors influencing agricultural technology adoption and its' impact on teff productivity in Ethiopia using endogenous switching regression model. The result indicates that technology adoption is positively determined by sex, education, soil

fertility status, frequency of extension contact by development agent visits, whereas age, distance to main road, distance to the input and output market, parcel ownership and farm size influence negatively and significantly. The result of endogenous switching regression model found that adoption of improved teff has a positive and significant impact on teff productivity.

Hailu et al. (2021) analyzed the impacts of agricultural technology adoption on household food security among smallholder farm households using an endogenous switching regression model, the model result shows that the adoption of improved agricultural technologies significantly increases household caloric intake, dietary diversity, and food consumption scores.

Belay and Mengiste (2021) studied on adoption and impact of agricultural technology adoption on poverty reduction in Ethiopia using ESR. The results showed that farm household's decisions to adopt agricultural technologies are determined by the sex of the household head, accessibility of credit service, amount of savings, number of extension visits, membership of farm cooperatives and distance from the market.

In fact, the different studies review in this section indicates that the factors, which influence adoption of technologies, differ from one area to another, as well as from one type of technology to another. Thus, to identify pertinent factors affecting of adoption and their degree of influence, it is felt need to conduct area and technology specific study under a given farming environment.

Generally, government policies, technological change, institutional factors, and technology inputs delivery mechanism can affect the probability of technology adoption (Wabbi, 2002).

2.6. Conceptual Framework (CF)

The Conceptual Framework of the study was developed based on the existing literature that is the education status, poultry farming experience, land holding, off-farm income, sex of the household head, access to credit facility, family labor, livestock holding, participation in cooperatives, age of household heads, extension contact and distance to the nearest market influences adoption decision and intensity of exotic poultry breeds adoption whereas exotic poultry adoption decision also affects income and consumption expenditure per-adult equivalent of smallholder households.

The cash income generated from sale of egg, live chicken also helps to purchase different items for household consumption, and it improves households' welfare. The analytical framework below shows how these factors are interlinked and influence decision to adopt and how much to adopt (intensity). The first step is adoption decision of exotic poultry breeds, the second step is intensity of adoption, and the third is Impact of adoption decision on smallholder households' livelihood.

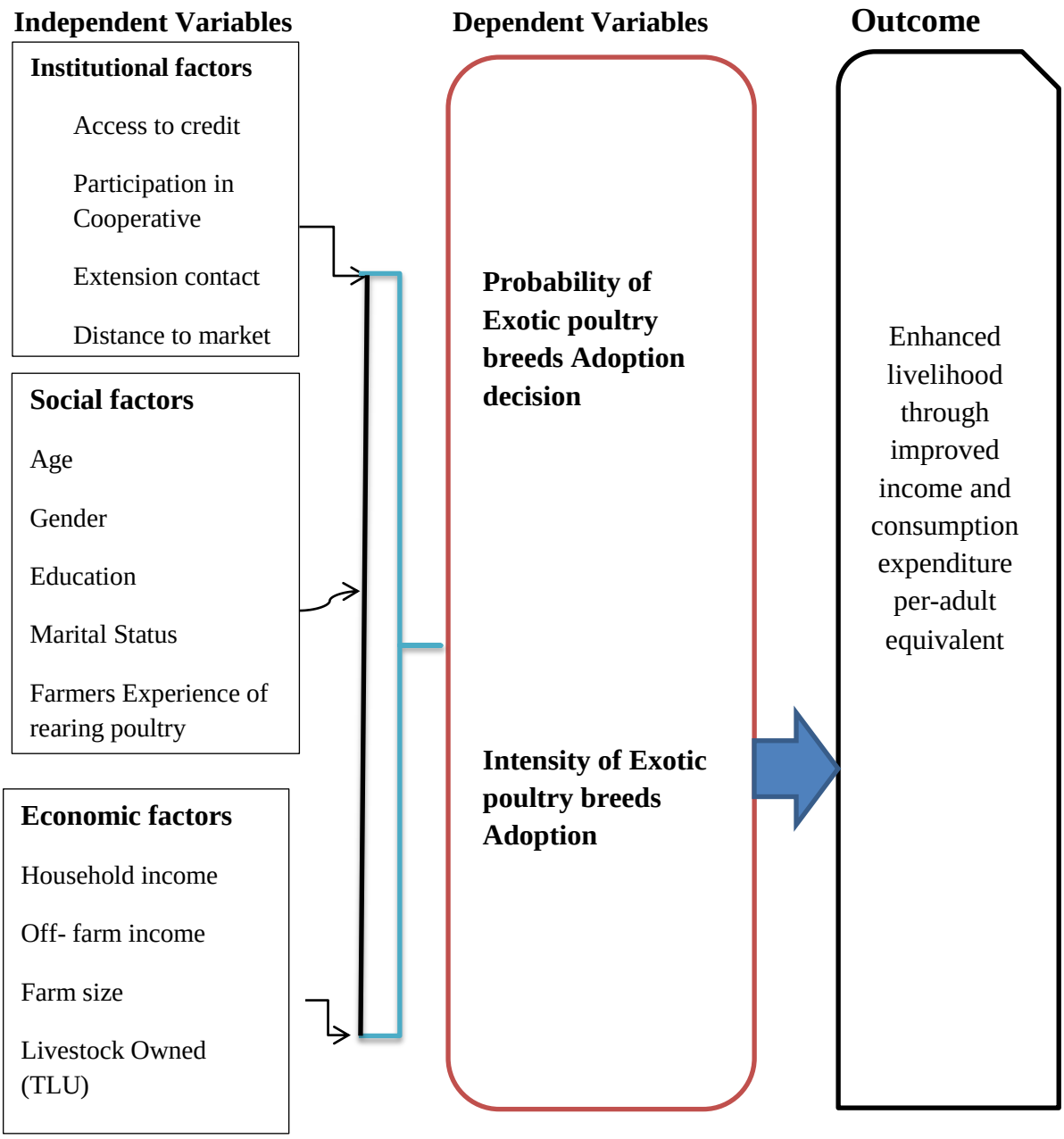


Figure 1: Conceptual Framework

Source: Adapted from Mathiu, E. 2021 and Literature Review

3. RESEARCH METHODOLOGY

This chapter discusses the methods that were followed in conducting the research. It addresses description of the study area, sample size, and sampling procedure that constitute the research design. Moreover, the data collection and analysis procedures are also discussed.

3.1. Description of the Study Area

This study was carried out in Dera Woreda of the Southern Gonder Zone of Amhara. Dera is one of the woredas in the Amhara region of Ethiopia. Dera is part of the south Gonder zone, and is bordered to the south by the Abay River that separates it from the east Gojam. To the west it is bordered by Lake Tana, to the north by Fogera, and to the east by Estie. Dera woreda covers a total area of 158,948 ha, of which 35% is plain, 20% is mountainous, 18% is gorges, and 27% is undulating. The altitude of the woreda ranges from 1,500 m to 2,600 m above sea level while the annual average rainfall is 1,250 mm. As to the agro-ecology, 85% is Woynadega while 15% is dega (source: Woreda office of agriculture, 2023). There are 36 kebeles in the woreda, of which 34 are rural kebeles and 2 are town kebeles. The total population of the woreda is 259,113 of which 132,367 are male and 126,746 are female. The number of households in the woreda is 51,129 of which 45,757 are male headed and 5,370 are female headed (source: Woreda Agriculture office, 2022).

The study area has a mixed crop-livestock farming system. Crops in the Woreda produce maize, figure milt, teff, rice, wheat, barley, flax and nuggets, as well as farmers such as potatoes, onions, legumes and cereals as well as tomato products.

According to the information obtained from the DWLFO (2022) the estimates of animal population by their types are 288,451 cattle, 92,701 sheep, 51894 goats, 40,965 donkeys and 2607 mules, 1720 horses, 196,082 poultry. Livestock production plays a crucial role in providing subsistence requirement and assisting crop production. Farmers more often sell sheep to earn income for regular expenses in the course of the year. During religious festivals when community members individually or collectively purchase animals for slaughter, there is higher demand in the town markets. Livestock and butter sales also make a substantial complement to the dominant crop sales.

Chickens are the most widely owned livestock by every smallholder farm households. However, the production system is traditional with no commercial poultry production system in the district so far. A number of households in the area reared chickens primarily for the household consumption purpose, hatching of eggs and cover the household expenses. To develop the chicken productivity exotic chickens essentially Rhode Island Red, Bovans Brown and White Leghorns were disseminated to farmers for a decade. Due to the superior egg production capacity of the exotic poultry breeds, rearing the exotic poultry breeds by the farmers is showing an increment from year to year relative to the past trends.

Therefore, both crops and livestock contribute their share to the farmers' agricultural income and food security. Hence, assessing factors that affect the farmers' decision to adopt exotic poultry breeds is important to improve the adoption of the breed in the study area and help decision makers to get an insight.

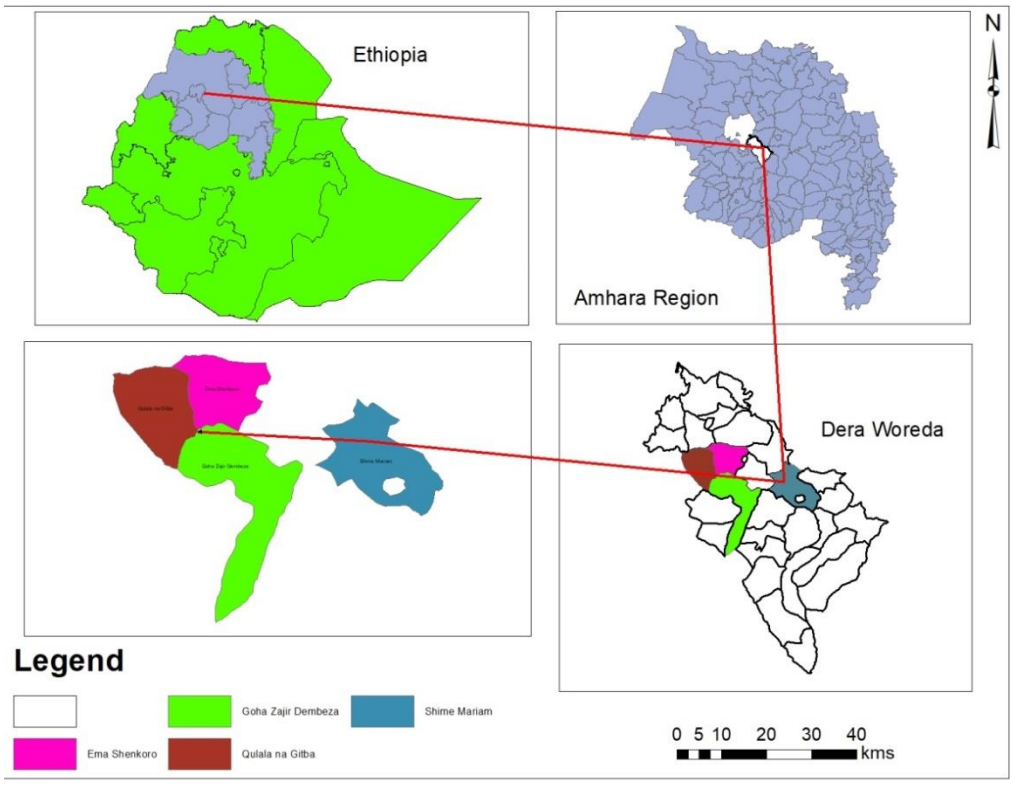


Fig. 2 Lcation map of the study area

Source: Dera District Agricultural Office (2022)

3.2. Sampling Techniques and Procedure

The data was collected from purposively selected four Kebeles of the district administration. The selection was done with the help of experts from Livestock and Fishery Office (LFO) of the district based on their prior experience in exotic chicken production, proximity to a road, high potentiality of exotic chicken distribution from high and midland agro-ecologies.

Multi-stage sampling method was employed to draw sample respondents from each Kebelles. About 189 sample households were selected for the study. The probability proportionate to size (PPS) method was used to obtain the number of sample respondents from each of the selected Kebeles, the exotic breed users and non-users to be interviewed from the four kebeles. First, based on the list document available with DAs, the number of user and non-user household from each kebele was determined. PPS formula was applied where the number of households in the each kebeles was divided by the total number of households in all four kebeles and then multiplied by the sample size as shown below Mathiu, E. (2021).

$$M = \frac{n}{N} * 189$$

Where M is the number of households to be interviewed, n is the number of households in the kebele and N is the total number of farming households in the four kebeles.

Finally, sampled farmers were interviewed using semi structured questionnaire. The main reason for using this procedure was to avoid sample biasedness so that our sample can represent the entire population.

Kothari (2004) gives the formula for sample size determination for finite population in such treatment and non-treatment analysis. Given the precision, confidence level, population proportions p and q where q=1-p.

$$\text{n} = \frac{NZ^2pq}{e^2(N-1) + Z^2pq} \ldots\ldots\ldots\ldots\ldots (1)$$

Where, n stands for estimated sample size, e is the allowable error; N number of population under the study; z is confidence level. Accordingly, for this study, N=5,668 the total number of population under the study in the district. e=7% =0.07 the maximum allowable error set by

the researcher, p=0.5 the proportion of users of the agricultural technology in the district, q=1-0.5=0.5 the proportion of non-users taking confidence level of 95% or probability of 0.95), then the sample size of farm households was found to be 189 applying the above formula.

$$n = \frac{5668 * 1.96^2 0.5 * 0.5}{0.07^2(5668 - 1) + 1.96^2 0.5 * 0.5} = 189\ Hoseholds$$

Table 1. Size of sample HHs in the sample kebeles using Probability Proportion to Size (PPS)

S/n	Name of Kebeles	Total Number of HHS	Number of HHs		No. of Sample HHs		Total Sample Size
			Adoptors	***Non-Adoptors***	***Adoptors***	***Non-Adoptors***	
1	Emashenkoro	1145	456	689	15	23	38
2	Shime	1139	563	576	19	19	38
3	Kulala	1964	898	1066	31	35	66
4	Goha	1420	547	873	18	29	47
Total	**4**	5668	2464	3204	**83**	**106**	**189**

Source: Source: Computed from Secondary Data and Own Computation, 2024.

A discrete variable representing adoption or non-adoption was used to determine the probability of adoption. An adopter in this study is a farmer who was keeping exotic chicken in 2019 and was given a value of 1. A non-adopter was a farmer who might have or might have not kept before but did not have exotic chickens at the time of survey and given a value of 0. A continuous variable representing the proportion of exotic chickens out of the total number of chickens owned by an adopter was used to measure the intensity of adoption (Teklewold et al., 2006). In the study, the number of exotic chickens available in the hands of farmers used to calculate intensity of adoption. It was not possible to find a better measure of intensity as famers only adopted the exotic chicken breeds rather than the complete package.

3.3. Data Types, Sources and Methods of Data Collection

Data was collected from both primary and secondary data sources; and were quantitative and qualitative in nature. The primary data was collected through household surveys to obtain information on the household characteristics, contribution of poultry to household income and

consumption, access to extension services, credit, and other sources of household income and revenues of the exotic poultry production at the time of the survey. Furthermore, other information was collected from key informant interview (KII), focus group discussion (FGD) to demonstrate and strengthen quantitative data collected from the sample respondents.

In this study, household is defined as a unit consisting of the members who live together in a house. Household heads, referred to, as smallholder farmers in this study, interviewed and responded on behalf of their families. In our study, more male household heads interviewed than females. It was not possible to interview more females as it is custom that the household head responds and makes decisions on behalf of the family (Damisa & Yohanna, 2007). The women's decisions to keep even chickens would not have been binding unless the household head (males in most cases) agrees. Therefore, interesting insights from the women might have missed in this study. Data on socioeconomic and institutional factors hypothesized to explain farmer decision behavior regarding adoption of exotic poultry breeds were collected.

The respondents were informed about the objectives of the survey before the administration of the structured interview schedules. Eight enumerators were participated and trained on a data collection procedure. Information generated through the structured interview schedule was supplemented by FGD and KII. Due to time space and budget constraint, the FGD was held in Emashenkoro and Kulala kebeles with the total member in each group of seven in each of these two kebeles.

Data on issues such as status of exotic poultry breed in their village, purpose of poultry keeping and opinion of farmers on benefits of producing exotic poultry were collected. For this purpose, checklists were prepared and till the completion of the discussion to control the deviation of ideas. Additionally, nine key informants, those who have knowledge about the district, which includes elders; expert from Livestock and Fishery office (LFO) and development agents (DAs) working in the kebele were interviewed.

Secondary data was gathered from different relevant sources such as annual reports of Woreda Livestock and Fishery Office (WLFO), Central Statistical Agency, Research Center, different published and unpublished documents, research studies, websites, etc.

3.4. Methods of Data Analysis

Data were analyzed using descriptive statistics and the application of econometric model to answer the research questions. Descriptive analysis methods were employed to analyze the result of survey using frequency, mean, standard deviation, percentages, minimum and maximum based on the nature of data. To see the presence of statistically significant differences and the systematic association between those who adopt and those who do not in terms of some hypothesized variables, chi-square and t-test were used. The results of the analysis were presented by tables and figures. Moreover, STATA version 15 software was employed to analyze the data. Qualitative data were analyzed by narrating and describing to support the quantitative data used in this study.

The contribution of exotic poultry breeds to household income and consumption were analyzed using descriptive statistics such as frequency, mean and standard deviation. The t-test was used to see the significance difference between adopters and non-adopters. The reason here was to get insight on the potential contribution of exotic poultry adoption for households' income and support in consumption expenditure. In doing contribution of exotic poultry for household cash income, households have different income source apart from chicken production.

Thus, those income sources were identified and additionally income from the chicken was computed for adopters and non-adopters of exotic poultry. Accordingly, the income generated from poultry production by the sale of a live chicken and eggs of the two adoption categories were compared.

Finally, the impact of exotic poultry breeds to household livelihood (income and consumption) was analyzed using Full Information Maximum Likelihood Estimation (FIMLE) method- Endogenous Switching Regression Model.

3.5. Econometric analysis:

Based on the objective of the study appropriate techniques of analysis such as descriptive statistics, inferential statistics (t-test) was used to see the difference between adopter and non-adopter. The variables were also checked for any possible multi-collinearity among each

independent variables and the variance inflation factors (VIF) results were within the acceptable limit, which showed a VIF result (Appendex2) of less than or equal to 2 (Amanuel H.,2007).

The decision to choose adopting exotic poultry breed technology and its role in smallholder farmer's livelihood are endogenously related variables. This study employed A Double Hurdle approach to examine factors that determine the probability and intensity of exotic chickens adoption among rural producers in the study area and an Endogenous Regime Switching (ERS) regression approach to investigate the relationship between household livelihoods (consumption and food security) while accounting for the heterogeneity effects of households.

3.5.1. Double-Hurdle Model to Determine Adoption Decision and Intensity

A feature of many models of technology adoption, for example straightforward binary or censored data models, assumed to be the same as that which determines the intensity of adoption. Hence, for example, if a given farmers' characteristic is known to have a positive effect on the extent of adoption, then a very high value of this characteristic would certainly lead to the prediction of adoption for such farmer.

Tobit, Heckman and double hurdle model, in the literature, are commonly used in the existence of zeros or non-adoption. Tobit (Tobin, 1958) approach was applied by different researchers in analyzing determinants of technology adoption (Abera, 2013; Teklemariam, 2017). One of the drawbacks of this model is it assumes that the decision to adopt and how much to adopt are made all together. Theoretically, the decisions on whether to adopt and how much to adopt can be made jointly or separately (Berhanu and Swinton, 2003). However, the Tobit model used to analyze under the assumption that the two decisions are affected by the same set of factors (Greene, 1993; Desalegn, 2018).

Two step approach; crags double hurdle (Teklewold et al, 2006) and Heckman sample selection (1979) model have been widely used to overcome these restrictive assumptions. This approach relaxes the Tobit model assumption by allowing different mechanisms to determine the separate probability of adoption and intensity of use. The Heckman model offers a means of correcting sample bias arising from non-randomly selected samples. However, in this study

non-random sampling method was not used. Furthermore, Heckman sample selection bias was checked and there was no sample selection problem in the data as lambda value (p=0.977) of the Heckman model was insignificant. The Heckman and double-hurdle models are similar in identifying the rules governing the discrete outcomes. Heckman model as opposed to the double hurdle assumes that, there are no zeros observation in the second stage once the first stage passed. This means, once the household decided to adopt exotic poultry breeds, there is no room not to adopt.

Double Hurdle approach was used to analyze objective two. It is a parametric generalization of Tobit model developed by Cragg, (1971). Adoption is faced by two tiers. The first is whether to adopt or not to adopt the technology and second stage is related to level of adoption (Cragg (1971). The relationship between the two tiers is hypothesized to be linked (Berhanu and Swinton, 2003). Thus, many recent studies have analyzed this hypothesized relationship (Asfaw et al., 2011; Akpan et al., 2012; Katengeza et al., 2012; Mal et al., 2012; Gebremichael and Gebremedhin, 2014; Kuti, 2015; Desalegn, 2018).

The double-hurdle model is a parametric generalization of the Tobit model. In the model, two separate stochastic processes determine the decision to adopt and the intensity of adoption of exotic poultry breeds. The double-hurdle model has an adoption (D) equation:

$D_i = 1$ if D_i*>0 the farmer adopts exotic poultry breed and 0 if D_i*<0, otherwise

$D_i = \alpha Z_i + u_i$ ..... (2)

Being D^* a latent variable that takes the value 1 if the farmer adopts 0 otherwise, Z_i are explanatory variables that determine the probability of farmers adoption of exotic poultry breeds, α coefficient of parameters estimated and Ui is the error term with zero mean and constant variance.

The level of adoption (Y) has an equation of the following:

$Y_{i=Y_i^*} \quad if\ Y_i^* > 0\ and\ D_i^* > 0$ ..... (3)

$Y_{i=0\ otherwise}$

$Y^{*}{}_{=}\beta' X_i - V_i$ ..... (4)

Where, Y= number of exotic poultry breed kept by a household in a specific period, X_i – explanatory variables, β is a vector of parameters and V_i are error terms distributed as:

$$\begin{cases} U_{i\approx N(0,1)} \\ V_{i\approx N(0,\delta^2)} \end{cases} \text{..... (5)}$$

The log likelihood function for the double-hurdle model is represented by equation below.

$\log_L = \sum_{/0} \ln[1 - \Phi(\alpha Z_i')\frac{(\beta X_i')}{\sigma}] + \sum_{/+} \ln(\Phi(\alpha Z_i')\frac{1}{\sigma}\phi(\frac{Y_i - \beta X_i'}{\sigma})$.....(6)

Where Σ/0 = summation over the zero observations; Σ/+ represents summation over positive observations; Φ and ϕ (.) are the standard normal cumulative distribution functions and probability distribution functions respectively.

The study further carried out a regression using the Tobit model to compare Likelihood Ratio tests (LR) with results from combination of Probit and truncated estimates. This was done in order to determine whether these two regressions are statistically significantly different from each other. Furthermore, this was done to confirm which model was superior on adoption decision. Cragg's assumption of independence between error terms Vi and Ui which entails combination of probit model and truncated model are considered.

The Tobit model is represented as; $\lambda = \frac{\beta}{\sigma}$ and X=Z ---------- (7)

According to Greene (2000), the Likelihood Ratio statistic is computed using the following expression;

$\Gamma = -2[lnL_T - (lnL_P + lnL_{TR})] \sim \chi^2_{\mathrm{K}}$---------- (8)

WhereL_T –Tobit model likelihood; L_P –Probit model likelihood; L_{TR} - Truncated Model likelihood; k – independent variables.

3.5.2. Endogenous Switching Regression (ESR) For Impact of Adoption

The study addressed the selection and endogeneity problems by utilising the endogenous switching regression methods (Lokshin & Sajaia, 2011; Malikov & Kumbhakar, 2014).

Endogenous switching regression (ESR) designs account for endogeneity by estimating a simultaneous equations model with endogenous switching by full information maximum likelihood (Lokshin & Sajaia, 2004). Although it relies on normality assumptions like the instrumental variable methods, the approach is more efficient than instrumental variables techniques. ESR has the advantage of controlling for factors which affect the treatment itself and disentangling the factors influencing the outcomes among treated and control groups through modeling both selection and outcome equations (Besley & Case, 2000). Moreover, endogenous switching regression model controls for structural differences between adopters and non-adopters regarding the outcome functions accounting for selection bias arising from unobserved factors that potentially affect both adoption of exotic poultry breeds and the outcomes (Alene & Manyong, 2007; Seng, 2016). Various empirical studies have employed the framework to study impact of modern technologies on food security and welfare (e.g. Asfaw et al., 2012; Khonje et al., 2015; Shiferaw et al., 2014; Coromaldi et al., 2015) and impact of climate change adaptation on food security (e.g. Di Falco et al., 2011).

Decision to choose adopting improved poultry breed and its impact on the outcome variable (livelihoods) was estimated in two separate stages in the ERS regression approach. Using the binary probit model, the first stage, identifies factors which determine the decision of households using exotic poultry breeds. The second stage was estimated the coefficients for the effects of exotic poultry production on the outcome variables by considering two equations: one for those who adopt exotic poultry breeds and the other for those not adopted.

Unlike for continuous outcome variables, accounting for sample selection and endogenous switching for binary outcomes where the data is fit using non-linear models is challenging (Heckman, 1978, 1986; Miranda & Rabe-Hesketh, 2006). Hence, estimations using two-stage procedures (such as Heckman's sample selection model) would lead to wrong conclusions and produce inconsistent results. Consequently, we utilise the endogenous switching probit framework which is parallel to the endogenous switching regression for the continuous outcomes (Lokshin & Glinskaya, 2009; Lokshin & Sajaia, 2011; Miranda & Rabe-Hesketh, 2006).

Let the decision to use exotic poultry breeds be represented by the following latent response model:

$$y^*_i = \alpha + \sum X_i\beta + u_i, u \approx N(0,1) \qquad \text{---------- (9)}$$

If $y^* > 0, Y = 1$

If $y^* \leq 0, Y = 0$

Where *y** is the outcome variable (adoption of exotic chicken) equal to 1 if household *i* adopted improved chicken and 0 otherwise. X_i is a vector of values for the *ith* observation, β is a vector of Parameters to be estimated and $u_i$is the error term.

The number of average benefit gained by adult household members in adopting regimes is presented as:

Regime 1: $Y_{1i} = \mathrm{X}_{1i}\,\beta_1 + \varepsilon_{1\mathrm{i}} \quad \mathrm{D_i} = 1$ if Adopted ---------- (10a)

Regime 2: $Y_{2i} = \mathrm{X}_{2i}\,\beta_2 + \varepsilon_{2\mathrm{i}} \quad \mathrm{D_i} = 0$ if not adopted ---------- (10b)

Y_{1i} and Y_{2i} are the expected benefit gained in regimes 1 and 2, respectively; X_{ij} is a set of independent variables which explain the outcome variable; amount of income determined by household related and external factors that include demographic characteristics (sex, age, education, family size, and the like), asset (land, livestock) and institutional factors (credit, extension service, non-farm activities). Since Y_{1i} and Y_{2i} cannot be observed simultaneously, the covariance of the error terms $\varepsilon_{1\mathrm{i}}$ and $\varepsilon_{2\mathrm{i}}$ is undefined. However, $\varepsilon_{1\mathrm{i}}$ and $\varepsilon_{2\mathrm{i}}$ are internally correlated via the first selection equation (Equation (9)). Therefore, $\varepsilon_{1\mathrm{i}}$, $\varepsilon_{2\mathrm{i}}$, and μ_{i} have a trivariate normal distribution with the expected mean of zero and covariance of Ω, where Ω is defined as follows:

$$\mathrm{cov}(\varepsilon_{1\mathrm{i}}, \varepsilon_{2\mathrm{i}}, \mu_{\mathrm{i}}) = \Omega = \begin{bmatrix} \delta_\mu{}^2 & \delta_{1\mu} & \delta_{2\mu} \\ \delta_{\varepsilon 1\mu} & \delta_{\varepsilon 1}{}^2 & \vdots \\ \delta_{\varepsilon 2\mu} & \cdots & \delta\varepsilon_2{}^2 \end{bmatrix} \text{--- ---------- (11)}$$

where $\delta_\mu{}^2$, $\delta_1{}^2$ and $\delta_2{}^2$ are the variances of selection Equation (9), and error terms in Equations (10a) and (10b), respectively; $\delta_{1\mu}$, and $\delta_{2\mu}$ are the covariances of the error terms in the selection Equations (9) and (10), and μ_{i}, $\varepsilon_{1\mathrm{i}}$ and $\varepsilon_{2\mathrm{i}}$ are the covariances of the error terms in the continuous Equations (9) and (10), respectively.

The variance of the error term in selection Equation (9) $\delta_{\mu}{}^{2}$, can be assumed to be unity as the estimation is done up to the scale (Maddala, 1986). The structure of variance –covariance relationship indicates that conditional expected values of the error terms ε_{1i} and ε_{2i} are different from zero. Therefore, the decision to adopt exotic chicken or not (selection equation) depends on the covariance between μ_i andε_{ij}. If the covariance $\delta_{i\mu}$ is statistically significant, then benefit gained, and the decision of choosing to adopt exotic chicken are correlated.

It is an indicator of the presence of endogeneity between the groups rather than simple sample selection bias in the household decision to adopt exotic chicken if benefit gained, and the decision of choosing to adopt exotic chicken are correlated.

It can be efficiently estimated using full maximum likelihood estimation method (Di Falco et al., 2011; Lee, 1997), and is provided as follows:

$$E[\varepsilon_{1i} \mid C_i = 1] = \sigma_{1\eta}\frac{\phi(Z_{i\alpha})}{\Phi(Z_{i\alpha})} = \sigma_{1\eta}\lambda_{1i}$$

$$E[\varepsilon_{1i} \mid C_i = 0] = -\sigma_{2\eta}\frac{\phi(Z_{i\alpha})}{1-\Phi(Z_{i\alpha})} = \sigma_{2\eta}\lambda_{2i} \quad \text{---------- (12)}$$

Where ϕ (.) is the standard normal probability density function, Φ (.) is the standard normal cumulative density function, and λ_{1i}=$\frac{\phi(Z_{i\alpha})}{\Phi(Z_{i\alpha})}$, and λ_{2i}=$\frac{\phi(Z_{i\alpha})}{1-\Phi(Z_{i\alpha})}$. Given the assumption of logarithmic likelihood function, the distribution of the error terms can be written as:

$$\ln L_i = \sum_{i=0}^{N} C_i \left[\ln\phi\left(\frac{\varepsilon_{1i}}{\sigma_1}\right) - \ln\sigma_1 + \ln\Phi(\theta_{1i})\right] + (1 - C_i)\left[\ln\phi\left(\frac{\varepsilon_{2i}}{\sigma_2}\right) - \ln\sigma_2 + \ln(1 - \Phi(\theta_{2i}))\right] \quad \text{..... (13)}$$

Where,$\theta_{ji=}\left(Z_{i\alpha} + \rho_j\,\varepsilon_{ji}/\sigma_j\right)/\sqrt{1-\rho_j{}^{2}}$, j = 1, 2, with ρ_j indicating the correlation coefficients between the error term μ_i of selection equation and the error term ε_{ij} of Equations (10a) and (10b).

Further, estimations of treatment effects were made. Average Treatment effect on the Treated and Untreated (ATT and ATU) computed using the results for expected values of the dependent variable for users and non- users in actual and counterfactual scenarios:

$$E(Y_{1i}|C_{i=}1\,, X_{1i}) = \beta_1 X_{1i} + \sigma_{\epsilon 1\mu}\rho_1\frac{\varphi(Za)}{\phi(Za)} \quad \text{..... (14)}$$

$$E(Y_{2i}|C_i = 0\ , X_{2i}) = \beta_2 X_{2i} - \sigma_{\epsilon 2\mu}\rho_2 \frac{\varphi(Za)}{(1-\phi(Za)} \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

$$E(Y_{2i}|C_i = 1\ , X_{1i}) = \beta_2 X_{1i} + \sigma_{\epsilon 2\mu}\rho_2 \frac{\varphi(Za)}{\phi(Za)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

$$E(Y_{1i}|C_i = 0\ , X_{2i}) = \beta_2 X_{2i} - \sigma_{\epsilon 1\mu}\rho_2 \frac{\varphi(Za)}{(1-\phi(Za)} \ldots\ldots\ldots\ldots\ldots\ldots (17)$$

ATT is the difference between the expected value of the outcome variable from equation 14 and 16. It is the difference between the expected value of the dependent variable for users and if they had not adopted. ATU is the difference between equations 15 and 17 estimating the difference between the expected value of the outcome variable for non- users and if they had adopted the improved chicken.

The main advantage of an Endogenous Switching Regression (ESR) model is its capability to estimate the effect of the variable under consideration for actual and counterfactual (hypothetical) conditions.

3.6. Definitions of Variables, Measurement and Hypothesis

Once the analytical procedures and their requirements are known, it is necessary to identify the potential explanatory variables and describe their measurements. Identifying and defining dependent and explanatory variables for the study of adoption decision is based on theoretical background and empirical findings.

3.6.1. Dependent Variables

Adopters are a farmer who has adopted a technology and continued using it, whereas, non-adopters are those who have never tried that technology (Van den et al., 1996; Doss, 2006). Adopter in this study is a farmer who was keeping exotic chicken in 2022 and/or before this year and have exotic chickens at the time of survey was given a value of 1. A non-adopter is a farmer who might have or might have not kept before but not have exotic chickens at the time of the survey and was given a value of 0.A continuous variable representing the proportion of exotic chickens out of the total numbers of chickens owned by an adopter was used to measure the intensity of adoption (Teklewold et al., 2006).

The decision to adopt exotic poultry breeds: dummy dependent variable, which takes 1 if the household keep exotic poultry breeds and 0 otherwise for the first-hurdle (probit regression) of the double-hurdle model.

The intensity of exotic poultry breeds adoption: continuous dependent variable that represents the numbers of exotic chickens available in the hands of farmers used to calculate the intensity of exotic poultry breeds adoption for the second-hurdle (truncated regression) of the double-hurdle model.

The Impact of exotic poultry breeds adoption: continuous dependent variable, which represents the benefit from adoption of exotic chickens that brought impact on the livelihood of farmers using ESR treatment effect.

3.6.2. Independent Variables

The independent variables are those variables which were hypothesized to have links with the adoption by farmers in exotic poultry adoption practices. Based on theoretical background and empirical results of different studies on adoption of exotic poultry practices, and adoption of other agricultural technologies selected socio-economic, and institutional variables were hypothesized to influence the farmers' decision to adopt and intensity of exotic poultry breeds in the study area.

- **Socio-economic factors**

Sex of Household head (SEXHH): It is a dummy variable represented as 1, if sex of the household head is male and 0, otherwise. The study conducted by Teklewold et al. (2006) and Teha (2007) indicates that, male household heads have more likely to adopt exotic poultry than female-headed households. Other studies Wondemeneh et al. (2015) and Simegnew et al. (2015) showed that the male farmers had a lower intensity of adoption than female farmers.

Therefore, it was difficult to forecast a prior, whether it influences the decision of farmers to adopt improved poultry breeds positively or negatively.

Age of household head (AGEHH): It is a continuous variable and measured in years. Younger farmers are more likely flexible and they are nearby to access information on the technology. The finding of Wondemeneh et al. (2015) revealed age negatively influencing

exotic poultry adoption. Thus, age was hypothesized to affect exotic poultry adoption negatively.

Education status of the household head (EDUCHH): refers to education status of household head. It is dummy variable and takes a value 1, if a household head is literate; and 0, otherwise. When household head is literate, the greater is the possibility for farmers to become aware of the importance of improved poultry breed (Grazhdani et al., 2013). Thus, education was hypothesized to influence the probability and intensity of exotic poultry breed adoption positively.

Experience of rearing exotic poultry (YRSPOULTRY): It is a continuous variable that measures the numbers of years since the household adopted exotic poultry breed. Experience of participant in the technology is one of the factors that determine the farmers' decision to adopt the technology. Those early adopters may test the benefit derived from technological advancement in inputs better than those who adopted the technology recently. Teklewold et al. (2006a) reported that poultry technology experience positively influenced exotic chicken breed adoption. Moreover, Dehinenet et al. (2014a) reported that farming experience played significant roles on the probability of dairy technology adoption and intensity. It was therefore, hypothesized that those producers with more years of experience in adoption of poultry technology are more likely to increase the probability and intensity of adoption.

Farm Land size (LANDSZE): Continuous variable refers to total farmland holding of farmers in ha. It is often correlated to farm income and wealth, which may help to invest in new technologies. Those households who have large farmland may have more capital to adopt poultry technologies. Previous research results reported by Ermias (2015) confirmed that farm size has a positive influence on technology adoption. Another study by Wondemeneh et al. (2015), a marginal increase in farm size resulted in a significant decrease in the number of exotic chickens. Therefore, it was difficult to forecast a prior, whether it influences the decision of farmers to adopt exotic poultry breeds positively or negatively.

Livestock holding (LIVSTKHOLD): It is a continuous variable. It refers to the total number of livestock holding of the farmer measured in Tropical livestock unit (TLU). It is used as an indicator of wealth. Those households who have a large number of livestock may have more

capital to adopt poultry technologies. Previous works by Endrias (2003) and Haji (2003) confirmed that livestock holding has a positive influence on technology adoption. In this study also, livestock holding was expected to influence the probability and intensity of exotic poultry breeds' adoption positively.

Household size (MENEQV): It is a continuous variable, refers to the total number of family members in man equivalent. Family members are considered as a source of labour for poultry management. Therefore, households with more family size are more likely to be adopters than with lower family size. The previous works of Dehinenet et al. (2014), Mekonnen et al. (2010) and Simegnew et al. (2015) confirm that, family size positively influence adoption of new technology and intensity of use.

Off-farm income (OFFFARMINC): It is a continuous variable measured as a total income (ETB) households earned from activities such as engaging in daily labor, petty trade, handcraft work, remittance, civil service, selling of fire wood, gift, etc. Off-farm/non-farm employment increases the additional income of the household and develops the capacity to invest in technology adoption. Participation in off-farm/non-farm activities are expected to positively influence farmers' adoption decision and intensity (Tura et al., 2010). However, if a farmer is practicing different off-farm/non-farm activities, which pay better than poultry production or compete for resources, it may negatively affect the decision to adopt because of opportunity costs (Jebessa, 2008). Therefore, it was difficult to forecast a prior, whether it influences the decision of farmers to adopt exotic poultry breeds positively or negatively.

- **Institutional Factors**

Access to credit (CREDIT): Access to credit enables the farmers to adopt the technology, which otherwise may not be affordable for them. It is a dummy variable, which takes the value 1 if the farm household used credit and 0 otherwise. Use of credit is expected to influence adoption and intensity of exotic poultry breeds positively (Tura et al., 2010, Simegnew et al., 2015 and Wondemeneh et al., 2015). Thus, access to credit service was expected to affect exotic poultry adoption positively.

Extension contact (EXTENSION): A continuous variable measures the frequency of monthly contact with the extension agent. It is obvious that agricultural extension is the most important source of information for rural farming household about agricultural technologies. Similar studies conducted by Degu (2012), Eboji et al. (2012), Dehinenet et al. (2014) and Zanu et al. (2012) found that extension contact positively affected the adoption and intensity of new technologies by exposing farmers to new information and technical skills. In this study higher frequency of agricultural extension contact was hypothesized to positively influence adoption of exotic poultry breeds.

Participation in cooperatives (PARTCOOP): is household's membership and/or in the leading position in cooperatives. It is a dummy variable which takes the value 1 if a person participates and 0 otherwise. The cooperatives serve as an important source of credit and input. Due to this, a farmer who is a member of cooperative has more chance to get credit for farm input. Therefore, being member of cooperatives, farmers were expected to have a positive and significant relationship with adoption and intensity of improved poultry breeds.

Distance to the nearest market (MARKTDSTNCE): the household distance taken to the nearest market of poultry. This variable is treated as a continuous variable measured in kilometer. As market distance increases adoption of exotic poultry breeds expected to decrease. If the households located near to market tend to buy exotic poultry breeds inputs and they can have easy access to sell their product in the market and it was hypothesized to be positively related to the probability of adoption and intensity of innovation (Feleke & Zegeye, 2006; Simegnew et al., 2015).

Table 2. Summary of variables included in the model

Variables	Type	Measurement of variable	Expected sign
Dependent variable			
Adoption decision	Dummy	1= if adopt exotic poultry breed ;0, otherwise	
Intensity of adoption	Continuous	Ratio of exotic poultry breeds kept	
Impact of Adoption	Continuous	Average Amount of ETB	
Explanatory variables			
Sex	Dummy	1= if sex of household head is male and 0 otherwise	-/+
Age of the HH	Continuous	Measured in years	-
Marital Status the household Head	Dummy	1= if household head is married and 0 otherwise	-/+
Education status of the household head	Dummy	Education status of the household head 1 = literate; and 0 = otherwise	+
Family Size	Continuous	Labor/day (men-equivalent)	+
Livestock owned	Continuous	Total number of livestock in tropical livestock unit.	+
Farm size	Continuous	Total land size owned in hectare	-/+
Off-farm Income	Continuous	Total income gained from daily labor, petty trade, selling of fire wood, remittance etc in ETB	$-/_{+}$
Credit	Dummy	1= if household get credit 0 otherwise	+

Extension	Continuous	Total number of contact with extension agent per a month	+
Participation in Cooperatives	Dummy	1= if household is either member or in leading position in cooperatives and 0 otherwise	+
Distance from the nearest Market	Continuous	Distance to market In kilometer	-
Experience of rearing poultry	Continuous	poultry farming experience in years	+

Source: various literatures and logical relationship. (+) effects means the explanatory variables have positive effect on the probability and intensity of adoption. (-) effects means the explanatory variables have negative effect on the probability and intensity of adoption.

4. RESULTS AND DISCUSSION

4.1. CHARACTERISTICS OF SAMPLE HOUSEHOLDS BY ADOPTION STATUS

4.1.1. Status and extent of exotic poultry adoption in the study area

According to data collected from KII of DWLFO in the study area, poultry is the major livestock for the farming households next to cattle used for consumption and income generation. The attractive poultry market enable smallholder farmers, particularly the poor to cover family expenses, that is to discharge land tribute, educating children, purchasing food, cloth, farm input and the like in the study area. Exotic poultry adoption has been somehow getting attention by farmers because of high market demand of egg and live chicken, high egg production capacity, and early maturing chicks over the local one.

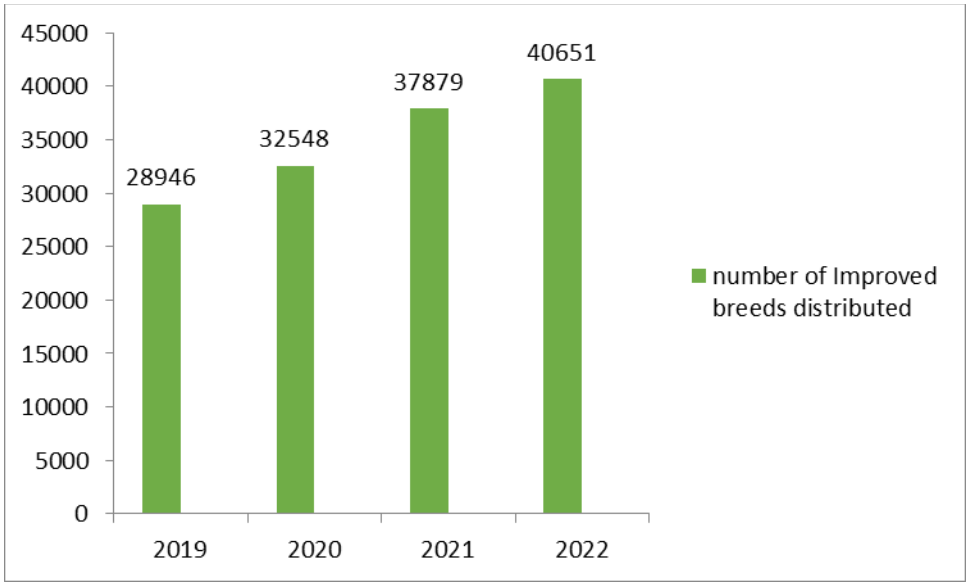
Exotic poultry introduction in this study area started a decade ago to the farmers to improve the productivity of the poultry sub-sector. Although many types of exotic chicken breed have been released in Ethiopia, only two of exotic chicken breed were introduced to the study area. Exotic breeds that the farmers rearing currently in the study area are Rhode Island Red and Bovans Brown.

The demand for Rhode Island Red poultry breed is increasing time to time. Key informants as pointed further support this idea; the status of the exotic poultry in the study area has been changing as it compared with the past trends. This is because of the role of extension services related to the poultry technology, attractive market price of a live chicken and eggs, easy adaptability of the breed (RIR) to the area, and early maturing chicks.

Furthermore, focus group discussion held in Kulala kebele said that, ‘‘*in the previous time we reared, local chicken for only consumption of egg, meat and hatch chicks because of their lower benefit from the sale. From the day we adopted exotic poultry, the aim of rearing poultry is changed from subsistence to market purpose because of attractive market price of a live chicken and egg compared to local one. In the previous time when we sell even two to three local breeds it was hardly possible to cover a little expenses but now this exotic chickens importantly brought changes in this aspects and enable us to cover very important expenses.*’’

Data recorded in the districts' Livestock and Fishery Office from production year of 2019-2022 was used as an input to get insight about the extent of distribution of exotic poultry breed in the study area. As a result, the extent of distribution of exotic chicken has shown an increasing scenario of the breed by the farmers. As the districts office, the increase in the distribution of the breed is due to the increase in the level of awareness of farmers on the benefits of rearing exotic chicken in helping the households to generate income and consumption. The adoption of exotic poultry breeds is presented in the Figure 3 below.

Figure 3. Exotic poultry breed distribution in the study area (2019-2022)



Source: Office of Woreda Livestock and Fishery, 2024

From the graph of exotic poultry data, we can understand that the user of the poultry technology increases from time to time in the study area. The total number of farmers that adopted exotic poultry in the year 2019 were 14,957 farmers, but, the number of farmers using exotic poultry technology reached more than 20,000 in year 2022 (DWLFO, 2022). In addition to earlier mentioned possibilities the reasons for increased user of the poultry technology were the exposure of the farmers to information, easy adaptability of the breed to the study area because of good agro-ecology, the size of the breed and extended laying period relative to local one. Despite, the increased adoption of the exotic poultry relative to the past

trend; the key informants indicated that the management of the poultry, especially housing system, feeding, watering and habit to vaccinate their poultry lags behind.

The total of 189-sample respondents was included in the survey, out of which 44% and 56% were adopters and non-adopters of exotic poultry breeds, respectively. The survey result revealed that from the sample adopter, 47.4% own Rhode Island Red (RIR) and 52.6% own Bovans Brown. The majority of the respondents (83.5%) got two months old chicks from LFO through GO and NGO facilitators based on their demand collected during extension service, while 17.5% from some NGOs for free.

According to the survey, the sample farmers own an average of 6.8 local, 4.1 exotic and 0.3 crosses (Table 3).

Table 3. Number and type of chicken owned by sample respondents

Item	Composition		
	Local	**Exotic**	**Crossed**
Chicken own	1050	635	44
Minimum	0	0	0
Maximum	19	14	5
Mean	6.8	4.1	0.3

Source: own computation, 2024.

Moreover, extent of adoption in this case was calculated by using the total number of exotic poultry owned in proportion with local breed. The survey result shows that, the minimum and maximum number of exotic poultry kept by adopters was 3 and 14 respectively while the mean numbers of exotic poultry breed for adopter was 4.1.

4.1.2. Sample Households characteristics in terms of hypothesized variables

The descriptive statistics such as percentage, mean, minimum, maximum and standard deviation as well as the probability levels of all explanatory variables were used to analyze and interpret the data. Inferential statistics such as t-tests for continuous, and chi-square tests ($\chi 2$) for dummy explanatory variables were used to examine data for differences and relationships to answer hypotheses. Table 4 and 5 below summarizes the descriptive analysis

result of the explanatory variables used to describe demographic, socioeconomic, and institutional characteristics of sample households in the next section.

Table 4: Descriptive and inferential Statistics Summery of continuous variables

Variables	Adopters (N=83)		Non-Adopters (N=106)		t-value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation		
Age of Household	44.23	6.011	45.52	7.859	-1.238	0.217
Household Size	3.9482	1.37941	3.184	1.04135	4.34	0.000
Flock Size	10.47	2.864	1.66	2.018	24.777	0.000
Livestock Holding	3.61605	1.030082	2.91262	0.949799	4.868	0.000
Farm Size	2.56855	0.76043	2.13189	0.669016	4.193	0.000
Extension Contact	3.69	1.219	2.4	0.923	8.285	0.000
Experience of rearing poultry	5.77	2.431	1.64	2.351	11.806	0.000
Distance to Market	3.45843	1.208451	3.84340	1.331989	-2.053	0.041
Annual income from poultry (ETB)	24,499.52	6,702.11	2,237.62	2,670.04	31.2	0.000
Annual expenditure for poultry production (ETB)	7,695.36	2,105.15	523.8491	782.68411	32.353	0.000
Off-Farm/Non-Farm Income	2,813.61	6,597.69	687.1698	1,538.55	3.211	0.002

Source: Own computation, 2024.

Table 5. Descriptive and inferential analysis results of dummy variables

Variables	Answers	Adopters		Non Adopters		P-value
		Freq.	Percent	Freq.	Percent	
Sex of HH	Female	29	34.94	32	30.19	0.488
	Male	54	65.06	74	69.81	
Education Status	Illiterate	33	39.76	41	38.68	0.880
	Literate	50	60.24	65	61.32	
Marital Status of HH	Single	29	34.94	22	20.75	0.029
	Married	54	65.06	84	79.25	
Participation of the HH in Cooperatives	Not member	1	1.20	45	42.45	0.000
	Member	82	98.80	61	57.55	
Access to Credit	Yes	83	100.00	66	62.26	0.000
	No	0	0.00	40	37.74	

Source: Own computation, 2024

- **Demographic factors**

Household size

The average household size of the respondents was 3.52 members in man equivalent (Table 6). The conversion factor used to estimate men-equivalent is shown in Appendix 2.The minimum household size of the sample households was 1 while the maximum was 7.8 in man equivalent, whereas the average household size of adopter and non-adopter was found that 3.95 and 3.18 in man equivalent respectively. The minimum and maximum household size of the adopter was 2 and 7.8 whereas 1 and 7.6 for non-adopter in man equivalent respectively. This implies that adopters have higher household size than non-adopters.

Table 6. Description of Sample households in Men-equivalent

Adoption Status of HH	Sex of Household	Mean	N	Std. Deviation	Minimum	Maximum	% of Total N
Non-Adopters for Exotic poultry	Female	2.9156	32	0.93295	1	5.1	16.9
	Male	3.3	74	1.07001	1.8	7.6	39.2
	Total	3.184	106	1.04135	1	7.6	56.1
Adopters of Exotic poultry breed	Female	3.6241	29	1.18221	2	5.9	15.3
	Male	4.1222	54	1.45507	2	7.8	28.6
	Total	3.9482	83	1.37941	2	7.8	43.9
Total	Female	3.2525	61	1.10869	1	5.9	32.3
	Male	3.6469	128	1.30685	1.8	7.8	67.7
	Total	3.5196	189	1.25706	1	7.8	100

Source: From own survey data, 2024

The mean difference between adopters and non-adopters for household size was found to be statistically significant at 1%.This implies that adopters have higher household size than non-adopters do. This may enable adopters to manage poultry effectively using their family labor.

Experience of rearing poultry

The average years of rearing poultry of the respondents was 3.46 with standard deviation of 3.144. The minimum year of rearing poultry of the sample households was 0 while the maximum was 13, whereas the average years of rearing poultry of adopter and non-adopter was found that 5.77 and 1.64. The minimum and maximum rearing experience of the adopter was 2 and 13 years whereas 0 and 9 years for non-adopters respectively. Thus, the result of t-test revealed that there was a significant mean difference between adopter and non-adopter in poultry rearing experience at 1%.

✍ Economic factors

Livestock holding

Tropical Livestock Unit (TLU) conversion factor was used (Appendix Table 1), to describe the livestock holding of the sample households. In terms of livestock wealth, adopters own an average of 3.616 TLU and it was 2.912 TLU for non-adopters. Thus, the result of t-test revealed that there was a significant mean difference between adopter and non-adopter in livestock holding at 1%.This implies that adopter own more livestock than non-adopters'.

Flock Size

In this study, flock size used to describe the number of chicken kept by respondents during survey in the study area. In terms of the number of chicken reared, adopters own an average of 10.47 and it was 1.66 for non-adopters. The average flock size poultry of the respondents was 5.53 with standard deviation of 5.007. The minimum number of poultry of the sample households was 0 while the maximum was 16. The minimum and maximum number of poultry kept by the adopter was 5 and 16 whereas 0 and 8 for non-adopters respectively. Thus, there was a significant mean difference between adopter and non-adopter in terms of the flock size kept at 1%. This implies that adopter own more number of poultry than non-adopters.

Farm size

The average land holding of the total sample was 2.324 hectare. The minimum and maximum total land holding of the respondents ranges from 1.125 to 5 ha. Results from survey data report shows that adopters are better off in terms of key assets like large farm holding than non- adopters. The t-test result showed that the mean difference between adopter and non-adopter was statistically significant at 1%. This implies that adopters have larger land holding than adopters. Here the indication for this is that, those households who have large farmland may have more capital to adopt poultry technologies.

Off-farm/non-farm income

The majority (76.2%) of total sample households had not involved in off-farm/non-farm income and the rest 23.8% of them participated in off-farm/non-farm income. Moreover, the

average annual off-farm/non-farm income of the adopter and the non-adopter of the improved poultry were 2,813.61 ETB and 687.17 ETB, respectively. Farmers in adopter group had a significantly higher off-farm/non-farm income than farmers in non-adopter group and significant at 1% level of significance. The main off-farm/non-farm activities that sample respondents engaged in were wage labour, petty trading, handcraft, sell of local drink ('*tela*' it is a local drink prepared from barley crop) and remittance. Here also the implication is that adopters have better off/non-farm income than non-adopter.

- **Institutional factors**

Access to credit service

Credit is an important institutional service to finance poor farmers for input purchase and ultimately to adopt new technologies. However, some farmers have access to credit while others do not due to problem related to repayment. The survey result indicated that 100% of the adopter, 62.6% of the non-adopter and 78.8% of the total respondents had access to formal credit source during the survey year.

Extension contacts or service

Frequency of contacts with the extension agents' made with farmers is important for proper exotic poultry adoption. Because, farmers who made contacts with the extension agents technical support and aware of the advantage of rearing exotic poultry breed. The adopters' average extension contact per month was reported 3.69 during the same year with a standard deviation of 1.219 whereas non-adopters were 2.4 per month with a standard deviation of 0.928.

The mean difference was found to be statistically significant at 1%. Furthermore, about the frequency of extension contact among the total respondents, 53.6% had contact of three times and more per month; about 46.4% had two and less times per month with DAs

Participation in cooperative

Agricultural cooperatives serve as an important source of rural credit and input supply. A farmer who is a member of the cooperative has more chance to get credit. Therefore, the

participation in cooperatives had significant percentage difference between adopters and non-adopters at 1% level. The majority (75.6%) of total sample households found to be cooperative members and the rest 24.4% reported to be non-members. 98.8% of adopters and 57.55% non-adopters were participant in cooperatives.

Distance to the nearest market

The households situated nearby to market are likely to buy agricultural inputs and they can have easy access to sell their product in the market. The survey results indicated that, the average distance of respondents' home from the nearest market place was 3.67km. On average adopter were located about 3.45 km and non-adopter were about 3.84 km away from the nearest market. This implies that adopters are living near to market than their counterparts.

4.2.Determinants of Adoption of Exotic Poultry Farming and Intensity of Use

The double-hurdle econometric model presented to estimate the factors that determine exotic poultry adoption in the study area. The study had used eight continuous and three dummy variables and entered into the double-hurdle model regression analysis.

Table 7 illustrates the LR –test results which suggest the rejection of the Tobit model. The test statistic Γ = exceeds the critical value of the χ2distribution as shown in Table7.

Table 7: LR –test statistics on double hurdle (Probit + Truncated model) versus Tobit model

	Probit, D	Truncated, Y>0	Tobit, $0 \leq Y \leq 1$
Log likelihood	-107.78	155.15	-165.97
No. of observation	189	103	189
Test statistics: $\Gamma = 426.68 > \chi^2_{0.05,14} = 23.68$			

Probit model likelihood = -107.78; Truncated Model likelihood = 155.15 and Tobit model likelihood = -165.97. Thus, the computation was;

Γ = -2 [-165.97 – (-107.78 + 155.15)]

$\Gamma = -2\ [-213.34] = 426.68$

The above test statistics was $\Gamma = 426.68$ and above the tabulated value [$\chi 2\ (14) = 23.68$] at a 5% level of significance. Thus, the double hurdle fitted the data better in comparison to Tobit Model. This implied that farmer's decision on adoption and the level of adoption of the improved exotic poultry breeds were made at two separate stages. The test conforms to the previous studies whose results revealed that decision to adopt and intensity of agricultural technologies was made in two separate stages like (Asfaw et al., 2011; Kuti, 2015; Gebremichael and Gebremedhin, 2014; Katengeza et al., 2012; Akpan et al., 2012; Weyessa, 2014).

4.2.1. Determinants of household exotic poultry adoption decision

The study considered factors related to economic, institutional, and demographic features relevant to the exotic poultry adoption. From the eleven explanatory variables hypothesized to influence the adoption decision, eight of them found to be significantly influencing the probability of exotic poultry adoption.

These include livestock holding, experience of rearing poultry, participation in agricultural cooperatives, distance from the nearest market and extension service significantly influenced exotic poultry adoption at 1% whereas family size influenced exotic poultry adoption significantly at 5%. Farm size and Off-farm income of the household significantly influenced exotic poultry adoption at 10%. On the contrary, the remaining three non-significant explanatory variables were not the correct predictors of the adoption decision (Table 8).

Table 8. Factors affecting adoption of exotic poultry adoption

Variables	Coefficient	Std.Err.	Marginal effect
Sex of Household	0.241	0.468	0.201
Age of Household	-0.0221	0.043	-0.028
Education Status of Household	0.244	0.462	0.0760

Household Family Size	0.436**	0.20	0.0464
Livestock Owned (TLU)	0.365***	0.114	0.065
Participation in Agricultural Cooperatives	0.322***	0.0773	0.1776
Farm Land Size	0.052*	0.377	0.0540
Off-Farm Income	0.085*	0.0473	0.0815
Extension Contact	0.0581***	0.189	0. 0478
Experience of Rearing Poultry	0.2092***	0.0397	0.0449
Distance to the Nearest Market	-0.2671***	0.0954	-0.03795
Constant	-10.292***	2.706	-10.292
Number of obs		189	
Pseudo r-squared		0.783	
LR Chi-square (12)		202.892	
Prob > chi2		0.000	
Akaike crit. (AIC)		82.312	
Bayesian crit. (BIC)		124.455	

Source: Own computation, 2024; *** p<.01, ** p<.05, * p<.1

The probit model estimation for the determinants of the probabilities of household to adopt exotic poultry or not are interpreted in relation to the significant explanatory variables in the model as follows:

Household Family Size: As expected, having large household size measured in man-equivalent positively and significantly influenced the probability of exotic poultry adoption at 5% level of significance. Consequently, the result of the model shows that if the household size increases by one unit in man-equivalent, thus the probability of adopting exotic poultry

increases by 4.64%, other variables being constant. This might be due to the fact that having more labor increases the capability of the household to manage chickens. This study is in agreement with the findings of Teklewold et al. (2006) and Dehinenet et al. (2014) which revealed that having large household size influences adoption of exotic poultry and dairy technology positively and significantly respectively. The finding of this study is also consistent with Tillahun (2013), who reported as family size the main source of labor for all types of farming, poultry, and livestock production activities undertaken.

Livestock Owned: Livestock possession was found to be positively influenced exotic poultry adoption decision and statistically significant at 1% level. The marginal effect of livestock possession implies that an increase in livestock possession by one unit in TLU would increase the probability of exotic poultry breed adoption by 6.5%, other variables being constant. The adopter of exotic poultry breed possessed significantly higher livestock in TLU than non-adopters. The result of this study confirms with the finding of Jebessa (2008) revealed that having large livestock affect adoption of exotic poultry breeds positively and significantly. On the contrary, this is inconsistent with the finding of Wondemeneh et al. (2015) which revealed that having large farm size decreases exotic poultry adoption.

Participation in Agricultural Cooperatives: Participation in cooperative was found to be positively and significantly affected exotic poultry adoption at 1% level. Holding other variables constant, the marginal effects of this variable showed that being a member of cooperatives, it increases the probability of adoption by 17.76%. This may imply that farmers who participated in cooperative were able to access and share information on exotic chicken production, access market information, and participate in collective action. This might also indicate a farmer who participates in cooperative may have frequent contact with DA's and would be more likely to have information about exotic poultry breeds and their characters than those who have never had a participate in cooperative. This finding is in agreement with Tura et al. (2010) and Jabessa (2008) which indicated that being a member of cooperatives increase the probability of technology adoption.

Farm Land size: Farm size was also found to have a positive and significant influence on farmers' likelihood to adopt exotic poultry at 10% level. The results on marginal effect indicate that if the land size increased by one unit (hectare), the probability of adoption

decision increased by 5.4 per cent while holding other variables constant. Farmers tend to allocate a relatively higher share of the land size in favor of the exotic poultry breeds. Moreover, adoption of exotic poultry breeds does not require huge capital to invest in and thereby serves as an incentive to allocate more resources on it. The results concurred with those of Akudugu et al., (2012) where farm size had a positive significance effect on adoption of modern agricultural production technologies by farm households in Ghana. The results also concur with results by Challa & Tilahun, (2014) where farm size had a positive effect on adoption of agricultural technology.

This finding is in agreement with the finding of Ermias (2015) which also indicated that large farm size positively and significantly influences exotic poultry adoption but contrary with the findings of Wondemeneh et al. (2015) which revealed that having large farm size decreases of exotic poultry adoption.

Off-Farm Income: other off-farm activities passed the first hurdle and positively affected the decision to adopt. This factor was statistically significant at 10% level of significance. This suggests that farmers who had adopted the exotic poultry breeds were endowed with additional sources of income from the non- farm activities and were able to purchase the exotic poultry breeds. The coefficient implied that while holding other variables constant, the probability of making the decision to adopt the exotic poultry breeds increased by 8.15 percent. Therefore, off-farm incomes had a strong positive role on the decision of the household adopting the technologies. This finding was consistent with the results of Beshir (2012) that revealed that the availability of off-farm income had a positive significant effect on adoption. The results contrast with findings of Akudugu et al. (2012) which indicated that off farm activities negatively affected adoption decision of modern agricultural production technologies by farm households in Ghana.

Extension Contact: As hypothesized, farmers' contact with extension agents positively influenced the adoption of exotic poultry at 1% level of significance. If the household increases its contact frequency with DAs by one unit, thus the probability of adopting exotic poultry increases by 4.78%, other variables being constant. This implies that farmers who have contact with extension agents become aware of and informed about new technologies in relation to poultry production packages becoming more effective than the farmers who do not

have extension contact. Hence, farmers having contact with extension agents could have a higher probability of adopting exotic poultry breeds than those who have not. The finding of the study is consistent with the findings of Ermias et al. (2015) which suggest that contact of extension agents with the farmers affect the adoption significantly and positively.

Experience of Rearing Poultry: As expected, the experience of rearing poultry had a positive and significant effect on exotic poultry adoption at 1% level. This result implies that those households who adopted exotic poultry breeds earlier derived the benefit from the technology more than late adopters, which might increase exotic poultry breed adoption of the household.

The marginal effect showed that, a one additional years the farmers adopts exotic poultry breeds, it increases the probability of adopting exotic poultry by 4.49%, other variables being constant. This finding also is in agreement with the finding of Teklewold et al. (2006) which suggests that farmer's poultry technology experience positively influenced exotic chicken breed adoption. Moreover, this finding is also in agreement with Atieno (2016) which revealed that poultry farming experience enhanced a farmer's knowledge and information and high skills in farming techniques and management, which improve the technical efficiency of farmers. Ermias et al., (2015) found that poultry technology experience positively and significantly influence the probability of chicken breed adoption.

Distance to the Nearest Market: As expected, distance to the nearest market was negatively affected households' likelihood to adopt exotic poultry and statistically significant at the 1% level. An increase in the distance that the households would travel to arrive at the nearest market by one kilometer would decrease the probability of the households to adopt exotic poultry by 4%, other variables kept constant and this resulted in increase in travel time and cost. Thus, those farmers located in distant and remote villages had less likelihood to adopt exotic poultry. This is consistent with the findings of (Feleke and Zegeye, 2006; and Simegnew et al., 2015) which indicated that distance to market have significantly and negatively affect the adoption of exotic poultry breeds.

4.2.2. Determinants of the intensity of exotic poultry adoption

This section deals with the results of truncated regression model estimating the determinants of the intensity of exotic poultry adoption that measured by the ratio of the total number of exotic poultry reared to total number of poultry owned by each household. Results showed that, the model was statistically significant at the 1% level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. The estimation result also showed that, intensity of exotic poultry breed adoption was influenced by sex of household head, marital status of the household head, annual income from poultry (ETB), annual expenditure for poultry production (ETB), and experience of poultry keeping (Years) (Table 9).

Table 9. Results of truncated regression for the intensity of exotic poultry breed adoption

Variables	Coefficients	Standard Error
Sex of the household	-.337**	.142
Age of the household (Years)	.006	.01
Marital Status of the household	.324**	.144
Education level of the household	-.151	.116
Active labor force of the household (Men-equivalent)	-.048	.046
Livestock holding of the household (TLU)	.148	.054
Land size of the household	-.027	.076
Cooperative membership of the household	.467	.458
Annual income from poultry (ETB)	.01***	.00533
Annual expenditure for poultry production (ETB)	-.00423**	.00166
Frequency of extension service (number)	.062	.052
Credit access of the household	-.309	.451
Proximity to nearest market (km)	-.009	.046
Experience of poultry keeping (years)	.4*	.022
Constant	1.574***	.547
Sigma	.556***	.034

Chi-square	7965.263
Prob > chi2	0.000
Akaike crit. (AIC)	259.180
*** *p<.01, ** p<.05, * p<.1*	

Source: Own computation, 2024

Sex of Household Head: the results from the analysis of intensity of exotic chicken breed adoption (Table 9) negatively affect as expected. Based on the analysis result male headed farmers had a lower intensity of adoption than their counterfactuals (female headed farmers) at $p < 0.005$). Poultry is more important for women and less well-off farmers than for rich people, and often-complementary activity. In this study, the importance of poultry to women in relation to the adoption of exotic chickens not fully captured because fewer women interviewed. It confirmed that poultry production is more important farm activity for women households (E. Wondmeneh et al., 2015). This result is in lined with the study conducted by E. Wondmeneh et al. (2015), Abadi et al., (2018) results of the model show that female farmers were found to keep more exotic poultry breeds compared to their male counter parts.

Marital Status of the Household: farmers who are married are more likely to adopt exotic poultry chickens than those who are not married at $p<0.05$ significant level. The truncate regression result shows that other factors kept constant, as the household become married, the household adoption of exotic poultry breeds increased by a factor of 0.324 than the households who are not married. This implies that, when the household become married most likely they focused on agricultural activities , especially for exotic chickens' adoption, while the wife need to keep poultry as a source for income. Similar results identified by Habte (2019).

Annual Income from Poultry: the result also showed that positive and significant influence on the numbers of exotic poultry kept at $p<0.01$ significant level. This means that as the income of the respondents emerged from poultry keeping increased, their intensity of adopting exotic poultry breed also increased significantly, other variables being constant. The implication of this result is that the gain of more income from poultry encourages the household to purchase more chickens with the income from poultry. This finding is consistent with (Tamir et al., 2015).

Annual Expenditure for Poultry Production: the result also showed that expenditure to poultry production of a household has a negative and significant influence on the numbers of exotic poultry kept at $p<0.05$ level of significance. Its coefficient showed that, as the expenditure of the households to keep the chickens increases by one unit in ETB, it decreases the intensity of adopting exotic poultry breed significantly, other variables being constant. The implication of this result may be having higher expense might divert the limited capital and active labor force available from exotic poultry management to other competing alternative income generating activities. Farmers compare the net benefit gained from different activities and invest their labor and money accordingly. This finding is similar with the study conducted by (Tamir et al., 2015).

Experience of Rearing Poultry: The experience of rearing exotic poultry was again found to be positively and statistically significant influence on the number of exotic poultry breed adoption at 1% level. The coefficient shows that, on the average the number of exotic poultry kept increase by about a factor of 0.4 if the time elapsed since the farmer adopted exotic poultry breeds increase by one year, other variables being constant. This might be those households who adopted exotic poultry breeds earlier derived the benefit from the technology more than late adopters, which might increase the intensity of exotic poultry breed adoption of the household. This finding is consistent with Quddus (2012) and Dehinenet et al. (2014) which revealed that technology experience positive influence on dairy technology adoption. Similarly, Teklewold et al. (2006a) reported that poultry technology experience positively influenced exotic chicken breed adoption.

4.2.3. Contribution of Exotic Poultry Adoption to Smallholder Farm Households

Income for household that is cash income came from the sale of crop production; livestock production and off/non-farm activities as the main source of capital to purchase farm inputs and other household consumable goods. Poultry income refers to the total annual earnings of the family from the sale of live chicken and egg after meeting family requirements. This is an important source of capital and helps to improve household capacity to buy other commodities, helps to cover some expenses and to educate their children.

The average annual income from poultry of the sample households was 12,014.01 ETB (Table 10). The maximum annual income from poultry was 37,440.00 ETB while the minimum was zero. On average, adopters had higher annual income from poultry of 24,499.52 ETB as compared, to non-adopters who on average had only 2,237.62 ETB. The t-test analysis result, therefore, revealed the total annual household income from poultry show that there is a significant mean difference between adopters and non-adopters at 1% significant level. This implies that, the higher income might come from the advantage the adopters obtained due to rearing exotic poultry. This also enables them to sell many eggs and a live chicken compared to local chicken producers.

Table 10. Average annual income and expenditure of the sample households

Annual Income and Expenditure	**Non-adopters of Exotic poultry breed**		**Adopters of Exotic poultry breed**		***t-value***	***p-value***
	Mean	**Std. Dev**	**Mean**	**Std. Dev**		
Annual Income of HH gained from Poultry Production in ETB	2,237.62	2,670.04	24,499.52	6,702.11	31.2	0.000***
Annual Expense of HH for Poultry Production in ETB	523.85	782.68	7,695.36	2,105.15	32.353	0.000***
Off-Farm income of the HH in ETB	687.17	1,538.55	2,813.61	6,597.69	3.211	0.000***
Total Annual Income Gained in ETB	62,558.47	20,907.78	89,786.90	24,873.33	8.172	0.039**
Total Annual Expenditure for	38,786.20	12,962.80	55,667.80	15,421.43	8.172	0.039**

Consumption in ETB						
Annual Income Gained from Livestock in ETB	29,231.42	10,332.90	30,624.40	8,377.64	0.998	NS
Annual Income Gained from Crop in ETB	30,402.27	10,746.86	31,849.37	8,712.74	0.997	NS

Source: Own computation, 2024; ***, **, * denotes significant at 1%, 5% and 10% and NS-Not Significant

The sample households' share of the poultry income to the total income was computed to get insight on contribution to the household income. The average annual income share from the sale of live chicken and egg was found to be 16.12%. Adopters gained advantage of 22,261.9 ETB of annual average cash income from sale of poultry than non-adopters. This result might indicate an exotic poultry breed keeping was more advantageous than rearing the local counterpart. This finding is in lined with the result of Mekonnen, 2007 which revealed that, although the obtained income does not add significantly to the income of local chicken keepers these results underlines the fact that local chicken sector is viable and promising alternative source of income for rural households.

Besides of cash income generated from poultry, households obtained income from livestock, crop, and off/non-farm activities. However, as the result shown under table 10 above the total annual cash earning from the sale of livestock and crop production of the household is positive and non-significant.

Another very important source of cash income in the study area likewise aforementioned cash income source of the sample households' was Off/non-farm income. As the result, the mean annual off/non-farm income of the sample households was 1,621.01 ETB. The maximum annual off/non-farm income was 36,700 ETB while the minimum was zero. On average, adopters had higher annual off/non-farm income of 2,813.61 ETB as compared, to non-adopters who on average had only 687.17 ETB (Table 10). Therefore, the t-test analysis result revealed that, total annual household cash income from off -farm show that there is a

significant mean difference between adopters and non-adopters at 1% level. This might be adopters participate in different income generating activities rather than limiting in one income source.

Moreover, the sample households compared with the total cash income. The total cash income of the households was from the sale of poultry, livestock, crop and off-farm activities. As the survey result, the mean total cash income of the sample households was 74515.93 ETB whereas the mean total cash income of the two categories (adopter and non-adopter) was 89,786.90 and 62,558.47 ETB respectively. Adopters had higher cash income than non-adopters with a t-value of 3.211 at 5% level. Accordingly, the mean difference between adopter and non-adopter found to be significant.

The mean, std. deviation, t-test and p-value were also used to analyze annul consumption expenditure status of the respondents. The average annual expenditure for poultry production (at 1%) and mean total annual expenditure for consumption (at 5%) consumed by sample respondent was found to be significantly different for adopters and non-adopters. The average annual expenditure for poultry production for adopters, 7,695.36 ETB, was higher than that of non-adopters, 523.85 (Table 12). This might be the reason that households rearing exotic poultry breeds generate more income than that of non-adopters and thereby getting a chance to buy different items for their chicken with relatively higher cost. Similarly, the average total annual expenditure to household consumption for adopters, 55,667.80 ETB, was higher than that of non-adopters, 38,786.20 (Table 10). Any increase in a household's food consumption reflects an improvement in that household's diet and exotic poultry producer has a better probability of diversifying their diet than non-adopters and enjoy improved livelihood than their counterparts.

4.3. Impact of Exotic Poultry Adoption on Livelihood of Smallholder Household Farmers

4.3.1. Endogenous Switching Regression: Treatment Effects

In this section, the study focused on the endogenous switching regression-based treatment effect results as followed. Full information maximum likelihood ESR model results as depicted in Tables 11 clearly shows that adoption of exotic poultry had a positive and

significant impact on household annual cash income and consumption expenditure per adult equivalent measured by ETB.

The ESR model results of the average treatment effects (ATT), accounting for selectivity bias arising from both the observable and unobservable characteristics, is presented in Table 11.

Table 11 . Impact of exotic poultry production on households cash income and consumption expenditure.

Outcome Variables	Household type and treatment effects	Decision Stage		Treatment Effect (ATE)
		To adopt	Not to adopt	
a) Annual Income of farmers	Adopters of exotic poultry breeds (ATT)	51809.82 (1142.30)	46344.34 (643.42)	5465.48*** (1411.40)
	Non-adopters of exotic poultry breeds (ATU)	49100.60 (450.31)	46091.97 (490.77)	3008.63*** (683.00)
	Heterogeneity effects (BH)	2709.22	252.37	2456.85
b) Consumption Expenditure	Adopters of exotic poultry breeds (ATT)	25435 (235.10)	19450 (1829.52)	5985.48*** (1194.42)
	Non-adopters of exotic poultry breeds (ATU)	18750.76 (198.31)	16230.54 (154.47)	2520.22*** (43.84)
	Heterogeneity effects (BH)	6684.24	3219.46	3465.26

Note. ATT – Average Treatment Effect on the Treated, ATU – Average Treatment Effect on the Untreated, ATE – Average Treatment Effects, BH-Base Heterogeneity effects; Standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01 (***, **, * denotes significant at 1%, 5% and 10%).

Table 11 presents the ESR-based average treatment effects of adoption of exotic poultry breeds for the outcome variables—annual cash income and consumption expenditure—under actual and counterfactual conditions.

The results from the endogenous switching regression-based treatment effects show that adoption of exotic poultry breeds has a positive and significant impact on annual cash income and consumption expenditure of farmers. The expected annual cash income of farmers for the households that adopt exotic poultry breeds is 51809.82 while it is 46091.97 for those who did not adopt. In the counterfactual case, households who adopt exotic poultry breeds would have average annual cash income of 46344.34 ETB had they decided not to adopt. Thus, the

households that adopt exotic poultry breeds annual cash income would decline by 5465.48 ETB had they decided not to adopt significant at the 1% level of significance. In the counterfactual case, for non-adopters their average annual cash income was 46091.97 ETB. The households' annual cash income would have increased by 3008.63 ETB amount had they decided to adopt the improved breed. In this regard, livestock in general and improved poultry keeping in particular being a key income source for the poor plays an important role in improving the livelihood of households, as livelihood improved with income.

Table 11 also shows that adoption of exotic poultry breeds is found to have a significant effect on consumption expenditure for farmer households at the 1% level of significance. The consumption expenditure was declined by 5985.48 ETB for adopting households had they decided not to adopt exotic poultry breed. In counterfactual households that did not adopt the breed would gain 2520.22 ETB to cover their consumption expenditure had they decided to adopt exotic poultry breeds. This result confirms that households can enjoy from the output gained from adopting and keeping exotic poultry breeds through market sale and family consumption. These results showed that decision to adopt the breed increased the livelihood of adopters and would have helped households that did not adopt. The result was consistent with the findings of Rawlins et al. (2014) who found that livestock also affects food security through the increase in total consumption expenditures that can contribute to their owner's ability to access food of all kinds. The result of model thus shows adopting exotic poultry breeds is the important determinants of households' livelihood.

The transitional heterogeneity effect is positive, implying that the impact of adoption on the outcome variables is significantly higher for farmers who actually adopted compared to those who did not adopt. These results are consistent with the position that the adoption of improved agricultural technologies improves yields (Abdulai & Huffman, 2014; Asfaw et al., 2012; Tufa et al., 2020).

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1. Summary

Poultry production is one of the key livestock subsectors in Ethiopia. It plays an important role in the human economy, supplying food, creating wealth through job creation for the booming population. Despite the importance of poultry in the household income, consumption, food security, and national economy, the supply did not satisfy the product need of people in Ethiopia because of low productivity of local chicken in terms of egg and meat production. As a result, exotic/improved chicken breeds promoted and disseminated in the rural and peri-urban parts of Ethiopia, to improve the productivity of the poultry to increase the income of farmers.

In Dera District (South Gonder zone of Amhara region), livestock, and fishery department disseminated various chicken breeds solely and in collaboration with different projects. However, the status of exotic poultry breeds distributed and disseminated towards the rural farmers by the nearby institutions and the impact of adopting exotic poultry breeds in enhancing livelihood outcomes on smallholder households not adequately studied in Dera district. Therefore, the study aimed at filling this existing knowledge gap. The objective of the study was analyzing the Adoption and Impact of Exotic Poultry Farming on Livelihood of Smallholder Farmers: The Case of Dera District, Amhara Region, Ethiopia

The study used a multistage sampling technique in the selection of representative sample from households. About 189 smallholder poultry producers were selected randomly from 4 kebeles based on Probability Proportional to the Size (PPS). Data collected from both primary and secondary data sources; and were quantitative and qualitative in nature. In addition to descriptive methods, the current study employed Double Hurdle and Endogenous Switching Regression models to analyze adoption and impact of exotic poultry farming in Dera district.

Adopters and non-adopters showed differences in most of the descriptive variables that expected to affect adoption of exotic chickens. There is significant difference between adopters and non-adopters of exotic poultry breeds. Adopters were keeping more poultry flocks and get frequent contacts with the extension agents, have experience of rearing poultry longer than non-adopters.

The contribution of exotic poultry breeds production to households' cash income from the sale of a live chicken and egg also compared for adopters and non-adopters. Accordingly, the t-test result revealed that, total annual household cash income from poultry showed that there was a significant mean difference between adopters and non-adopters at 1% level. The average annual cash income share from the sale of live chicken and egg was found to be 16.12%. Adopters gained advantage of 22,261.9 ETB of annual average cash income from sale of poultry than non-adopters.

Based on the objective, the study analyzed the factors that determine the adoption and intensity of use of exotic poultry breeds. In Probit regression model of the first hurdle, eight variables were found to significantly determine probability of adoption of exotic poultry breeds. These significant variables were Livestock Owned (TLU), Participation in Agricultural Cooperatives , Extension Contact service, Experience of Rearing Poultry and distance to the nearest market were found to influence exotic poultry adoption at 1% whereas Household Family Size at 5%. Moreover, Farm Land Size and Off-Farm activity found to influence exotic poultry adoption at 10%. The results showed the aforementioned variables positively and significantly influenced the decision to adopt exotic poultry breeds. However, from the significant factors distance from the nearest market negatively and significantly influenced the decision to adopt exotic poultry breeds.

Intensity of adopting exotic poultry technology was significantly influenced by the following factors. These are sex of the household head, household marital status, annual income gained from exotic poultry production, annual expenditure for exotic poultry production and experience of rearing poultry. The aforementioned variables except sex of the household head and annual expenditure for exotic poultry production had a positive influence on intensity of adopting exotic poultry breeds. The results of the study have shown consistency with those of studies done in determinants of adoption and intensity of technology adoption among the smallholder farmers.

This paper has also assessed the potential impact of the adopting exotic poultry on smallholder farmers' livelihood (cash income and consumption expenditure) in the study area. By using endogenous switching techniques, the impact of the adoption of exotic poultry breeds had estimated. The adoption of exotic poultry breeds have a positive and significant

impact on livelihood of smallholder farmers' annual cash income and consumption expenditure measured by ETB in the study area. The result showed households that adopt exotic poultry breeds annual cash income would decline by 5465.48 ETB had they decided not to adopt significant at the 1% level of significance. In the counterfactual case, households' annual cash income would have increased by 3008.63 ETB amount had they decided to adopt the improved breed. Similarly, the consumption expenditure would have declined by 5985.48 ETB for adopting households had they decided not to adopt exotic poultry breed. In counterfactual, households that did not adopt the breed would gain 2520.22 ETB to cover their consumption expenditure had they decided to adopt exotic poultry breeds. The difference in household income between the two groups shows that there is considerable room for improvement of household cash income through increasing the number of adopter of exotic poultry breed in the study area.

5.2.CONCLUSIONS

Poultry is the major livestock for the farming households next to cattle used for consumption and income generation, Dera district. The attractive poultry market enable smallholder farmers, particularly the poor to cover family expenses, that is to discharge land tribute, educating children, purchasing food, cloth, farm input and the like in the study area. Exotic poultry adoption has been somehow getting attention by farmers because of high market demand of egg and live chicken, high egg production capacity, and early maturing chicks over the local one.

Exotic poultry introduction in the study area started decades ago to the farmers to improve the productivity of the poultry sub-sector. Although many types of exotic chicken breed have been released in Ethiopia, only two of exotic chicken breed were introduced to the study area. Exotic breeds that the farmers rearing currently in the study area are Rhode Island Red and Bovans Brown. The current study was aimed to empirically measure adoption and impact of exotic poultry breeds in dera district.

Descriptive analysis results confirm that, adopter smallholder farmers are more advantageous than their counterparts. The findings also revealed that, farmers who adopt the technology were generating relatively higher cash income than non-adopters. Furthermore, findings

indicate that an exotic poultry breed keeping was more advantageous than those households rearing local chicken. Generally, adopters benefited more from adopting exotic poultry technology as compared to non-adopters in terms of increased household cash income gained from the sale of live chicken and eggs.

Probit results revealed that participation in agricultural cooperatives had the highest marginal effect on adoption. This implies that farmers who participated in cooperative able to access and share information on exotic chicken production, access market information, and participate in collective action thereby increased the likelihood of farmers embracing modern production technologies. Furthermore, from the results of truncated estimation, sex of the household head had the highest coefficients on intensity of adopting the technology. This finding confirmed that poultry farming is more important farm activity for women households than their counterparts.

The theoretical and empirical approaches that were adopted by this study produced satisfactory results. These results can be used in understanding the factors that underlie the adoption and the intensity of adopting exotic chicken breed technologies in the context of smallholder farmers. Furthermore, the study showed that the adoption and intensity stages are made successively which concurred with finding of previous studies. Thus, the double hurdle fitted the data better in comparison to Tobit Model. This implied that farmer's decision on adoption and the level of adoption of exotic chicken were made at two separate stages.

From the results of Full Information Maximum likelihood ESR –based treatment effect, findings revealed that adoption of exotic poultry breeds had positive income and consumption expenditure impact on both adopters and non-adopters of the technologies. That means as the farmers adopt and practice the exotic poultry breeds, their welfare in case of cash income and consumption expenditure improved indicating positive impact of exotic poultry breeds adoption on the livelihood of smallholder farmers.

The study concluded that the impact of adopting exotic poultry breed technology on the livelihood of smallholder farmers was higher compared to those local chicken keepers.

5.3. RECOMMENDATIONS AND POLICY IMPLICATIONS

Based on the findings there is the need for policies and strategies aimed at enhancing exotic poultry breeds adoption, the following points are recommended:

- More programs targeting women should be designed and supported by both the higher and district level decision makers. Poultry production is an enterprise that is more important for and associated with women as compared to men. Hence, due attention should be given to female farmers to economically empower them.
- Making the available household members well equipped with the necessary skill and awareness is important to increase the production performance of the exotic poultry breed.
- The district-concerned stakeholders should avail the poultry technology where the farmers easily access without incurring additional cost, because going a long distance to access the technology discourages farmers to adopt exotic poultry breed.
- Strengthen those farmers having a large farm to allocate the resource for exotic poultry farming technologies to realize the importance of diversifying their livelihoods sources through adoption of modern technologies such as improved poultry farming.
- There is a need for the district leaders to enhance extension services and experienced farmers who expressed significant willingness in the adoption of this technologies.
- Awareness creation of farmers having a large livestock holding, emphasis on the contribution of poultry to household welfare and on the relevance of exotic poultry adoption is vital.
- Further study needs to identify the common problems that affect exotic chicken adoption, assessing intensity of adoption of exotic poultry breeds and impact of exotic poultry on socio economic condition of farm households in the study area.
- There is a need for policy makers and other participants to develop appropriate extension programs that closely support and educate farmers on modern production innovations. Farmers also need to express extension demand by engaging in meaningful activities such as being member in cooperatives that share valuable information.

- Increased engagement of farmers in non-farm activities will increase farmers' income. This will increase the ability of smallholders to timely procure modern production inputs that are efficient in poultry farming.
- Promotion of exotic poultry breed technologies for wider adoption could generate tangible benefits to smallholder farmers in terms of increasing household income thereby improving smallholder farmers' welfare.
- Finally, since exotic poultry farming not only provide cash income for farm households but also generate a significant number of jobs, especially in rural areas where other income opportunities are limited, the future research of interest in improved poultry adoption should consider the impact of exotic poultry on other elements of poultry value chains..

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APPENDEX

Appendix 1. Conversion factor used to estimate Man-Equivalent Age group

Age group	Male	Female
<10	0.000	0.000
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
>50	0.7	0.5

Source: Desalegn Sh., 2018

Appendix 3. Conversion factor used to estimate Man-Equivalent

Age group	Male	Female
<10	0.00	0.00
10 13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
>50	0.7	0.5

Source: Desalegn Sh., 2018

Appendix 3: Multicollinearity test using VIF

Variables	**VIF**	**1/VIF**
Sex	1.71	0.585
Marital status	1.669	0.599
Extension frequency	1.54	0.649
Age	1.449	0.69
Man equivalent	1.42	0.704
Cooperative participation	1.37	0.73
Output Taste	1.281	0.781

Land size	1.27	0.787
Education	1.267	0.789
Market distance	1.249	0.801
Livestock holding	1.214	0.824
Mean VIF =1.403.		

Source: Own Computation, 2024

Appendix 4: Falsification test for instrumental variable

Variables	Model 1	Model 2
	Annual Income adoption of exotic poultries	Annual Income non-adoption of exotic poultries
Distance to market	-750.547 (687.004)	45.821 (523.502)
Constant	27,424.692*** (2,515.177)	9,029.391*** (2,128.352)
Observations	83	106

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Own Computation, 202