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Characterization of the Adoption of Village Poultry Technology Package Elements, Chicken Breeds and Forms in the Central Oromia Region, Ethiopia

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Abstract
The Ethiopian Ministry of Agriculture and Rural Development developed and disseminated village poultry technology package containing improved chicken breeds, improved poultry feeding, housing, watering and disease control. This study was conducted to characterize the adoption status of the technology package elements, chicken breeds and forms in different agro-ecological zones of central Oromia Region, Ethiopia. One hundred eighteen (180) village poultry technology package participants were used for this study. Structured questionnaire, field observations and focus group discussion were employed to collect detail information. The study revealed that respondents received 4.7(0.80) pullets with cockerel and 10.1(1.25) only pullets for the technology but their demands were 64.0(6.11) and 97.9(16.27) pullets with cockerels and only pullets, respectively. As compared with other technology elements, improved chicken breed adoption was better. The overall adoption level of the technology elements was 39.4%, where better adoption (48.3%) was in the highland and the least (33.3%) was in the lowland agro-ecologies. The mean adoption index was not significant among the study agro-ecologies. The overall adoption index of the technology was 0.34(0.03). In conclusion, the adoption level of technology is categorized as low level. Therefore, to improve the technology adoption, much effort is needed from concerned organizations, professionals and famers.
Keywords: Adoption; Technology element; Technology form; Package; Village poultry

1. Introduction

Ethiopian indigenous chicken ecotypes have limited genetic capacity for both egg and meat production (EARO 2000). As a result, the Ethiopian Ministry of Agriculture and Rural Development (MoARD) established poultry breeding and/or rearing centres to distribute improved chicken breeds to smallholder farmers. Since 1970s, Rhode Island Red (RIR), Bovan Brown and White leghorn chicken breeds with other packages were distributed to farmers through MoARD to increase egg and meat productions, and to improve the genetic potentials of native chicken ecotypes in different agro-ecological zones of the country (Alemu *et al.* 2008; Tegegne *et al.* 2010). During this period, millions of improved chicken breeds have been distributed in the form of fertile eggs, baby chicks, pullets and cockerels. Higher learning institutions, research organizations and NGOs also supported the technology package by distributing different forms of the same improved chicken breeds (Demeke 2008). The technology package mainly promote exotic chicken breeds distribution that perform better than local breeds in terms of meat and egg production with extension follow up and technical supports on improved poultry feeding, housing, watering and disease control (Teklewold *et al.* 2006).

Although the introduction and dissemination of improved chicken breeds was started with the expectation that the technologies can be adopted by farmers (Tadelle *et al.* 2002), however, there exists inconsistency between available literatures regarding the adoption rate of improved poultry technologies. For example, Mekonnen (2005) claim that the technology was not yet adopted and practiced by most of the farmers, while Teklewold *et al.* (2006) reported that about 41.5% of the smallholder farmers adopted exotic chicken breeds in east Shewa and Welayeta zones of the country. However, the adoption level of other village poultry technology package elements, chicken breeds and forms were not studied in detail. Moreover, agro-ecologies and other factors might influence technology adoptions. Therefore, this study was conducted to characterize the adoption status of village poultry technology package elements, chicken breeds and forms (fertile eggs, day old chicks, pullets, layers and pullets with cockerels) in selected agro-ecologies of central Oromia Region, Ethiopia.

2. Materials and methods

2.1 Description of the study areas

The study was conducted in the central part of Oromia Region located between 3°24'20" to 10°23'26"N latitudes and 34°07'37" to 42°58'51"E longitudes (OBoFED 2008). The region is characterized by vast geographical and climatic diversity having three major climatic categories called dry, tropical rainy and temperate rainy climates. Three districts, namely *Wolmera, Ade'a* and *Boset* were selected based on agro-ecology and history of poultry technology distribution.

2.2 Sampling procedures and sample size

Three districts *Wolmera* (highland), *Ade'a* (mid-altitude) and *Boset* (lowland) were purposely selected based on their agro-ecology and village poultry technology package interventions (CSA 2012). From each district, 5 *Kebeles* (farmers' administrations) were randomly selected; and using multi-stages random sampling method, 180 male and female technology package participants (12 participants per *Kebele*) were selected from technology participant lists obtained in the Office of Agricultural Development Agents.

2.3 Data collection

Structured questionnaire, field observations and focus group discussion were employed to collect information. The questionnaire were pre-tested and adjusted prior to the actual survey. Face to face interview and field observation were conducted to collect data and to see how the technology elements were managed by the technology participants. One focus group discussions were conducted per district with key actors of the technology to collect additional information. Five randomly selected farmers and 5 technology key actors (livestock Developmental Agent (DA), veterinarian, livestock expert, livestock team leader and poultry researcher) were involved in the focus group discussion.

2.4 Definition of adopters and non-adopters

To call the technology package participants adopter of each technology package element (improved chicken breeds, feeds and feeding, chicken housing, healthcare and water provision) and chicken forms, the farmer should fulfil the following minimum criteria at least for the last 5 years:

Chicken breeds adopter: The farmer should receive the technology more than once and have at least 5 exotic or crossbred chicken breeds.

Chicken forms adopter: Chicken forms in the present study includes: fertile eggs, day old chicks, only pullets (pullets without cockerel), pullets with cockerels and layers. The farmer should practice one or more of improved chicken forms.

Feeds and feeding adopter*:* The farmer must fulfil at least 3 of the following criteria: (1) Must supplement home mixed or formula rations or both for the chicken; (2) Must use home available or appropriate chicken feeding trough; (3) Should know whether home available feeds can satisfy the chicken nutrient requirement or not; (4) Adjusted the feed according to age and productivity of chicken; (5) Must offer enough amount of feed for his/her chicken per day.

Housing adopter*:* The technology participant must fulfil at least 3 of the following criteria: (1) Must construct the chicken house according to professionals' recommendation; (2) The chicken house should be separated from people and livestock houses; (3) The chicken should be kept in their house day and night or some hours during risky weather condition at day time and the whole night; (4) Consider space requirement of chicken; (5) The house must be cleaned daily or when all are out in case of deep litter housing; (6) Must disinfect the house before the next batch is in.

Healthcare adopter: The technology participant must fulfil at least 3 of the following criteria: (1) Knew when chicken get vaccinations; (2) Vaccinated the chicken; (3) Isolated sick chicken; (4) Consulted a veterinarian; (5) Knew treatment doses.

Provision of water adopter*:* The participant must fulfil at least 3 of the following criteria: (1) offered hygienic water for the chicken; (2) Used hygienic watering trough; (3) Offered the water *ad libitum* or throughout the daytime*;* (4) Cleaned the trough daily; (5) Changed the water at least 3 times per day.

Non-adopters*:* Are those farmers who could not fulfil the above mentioned minimum criteria.

3. Data analysis

Based on the criteria, technology participants who adopted each of the package elements took a value 1, otherwise 0. Then the adoption levels of each technology elements were computed per agro-ecology and expressed in percentage. Based on their adoption levels, technology elements were scored from 0 (nil adoption level) to 5 (highest adoption level). The total adoption score for a respondent was obtained by summing up the score obtained for each technology element. The minimum and maximum scores a respondent can score were 0 and 15, respectively. Then adoption index (AI) for each respondent was computed by dividing the sum of scores obtained for individual respondent to the total sum of the scores according to (Karthikeyan 1994; Zanu *et al.* 2012; Quddus 2012) as follows:

$$Adoption\ index\ (AI) = \frac{\text{Respondent's total score}}{\text{Sum of total scores}} \quad \ldots\ldots\ldots(1)$$

Based on computed adoption index, the technology participants were categorized into six adoption level categories; nil adopters (AI=0), very low adopters (AI up to 0.20), low adopters (AI 0.21 to 0.40), medium adopters (AI 0.41 to 0.60), high adopters (AI 0.61 to 0.80) and very high adopters (AI greater than 0.80). The first three were categorized as non-adopters and the last three were categorized as adopters.

Regarding other data sets, quantitative data were analyzed using GLM mean procedure of SAS version 9.0 and qualitative data were analyzed using SPSS version 20.0 software packages. Ranked variables were analyzed by using SAS NPAR1WAY Wilcoxon procedure of Kruskal Wallis test and ranked means were analyzed using SAS mean procedures. Cross-tabulation analysis used to compare adopters and non-adopters to particular technology elements, chicken breeds and forms across the study agro-ecologies. To locate the significant difference between quantitative data and ranked means, LSD means comparison tests was used. Similarly, chi-square test was used to test the significance level of qualitative variables.

4. Results

4.1 Socio-economic characteristics of the respondents

In this study, 65.6% and 34.4% of the respondents were male and female, respectively. As indicated in Table 1, the mean age of the respondents was 42 years. The family size ranges from 1-12 with a mean of 6 per household. There was no significant difference ($P>0.05$) in family size across the study agro-ecologies. Most of the respondents (39.4%) attended secondary education and above followed by respondents who attended (36.7%) elementary education. About 17.2% of the respondents attended basic educations (reading and writing) and very small proportions (6.7%) of the respondents were illiterate. About 38.9% of the respondents had nil or less than 1 ha farmland and most (65.6%) of the respondents had less than 2 ha of farmland. Farmers reside in the lowland agro-ecology had significantly ($P<0.001$) owned better farmland as compared to farmers reside in the highland and mid-altitude agro-ecologies.

4.2 Chicken farming and technology experiences

Chicken farming experience of the respondents ranges 5-58 years with a mean of 20.8 years (Table 1). Most of the respondents (47.8%) have 16-30 years of chicken keeping experiences. About 46.1%, 38.9% and 15.0% of the respondents have been engaged in village poultry technology package for up to 5 years, 6-10 years and over 10 years, respectively. About 1/4 (25.6%), 45.0% and 29.4% of the respondents received the technology more than twice, twice and only once, respectively. The credit service was limited and only 2.5% of the respondents received credit services and only 18.9% of the respondents got the technology inputs with price subsidy. Currently, there is no price subsidy for the technology inputs due to this the farmer pay for the technology inputs.

4.3 Source of information

Because of their close contact with farmers, Agricultural Development Agents (DAs) were the first major source of information for most of the farmers (71.7%) concerning village poultry technology package followed by farmer to farmer information exchange (18.3%). The contribution of mass media (2.2%), experts (3.3%), researchers (1.1%), written materials about poultry technology (1.1%) and NGOs (2.2%) as sources of information for the technology was very low.

4.4 Awareness level and perception of farmers

About half (49.4%) of the respondent farmers knew about the village poultry technology package before they acquire it. When this study was conducted most of the respondents were aware of improved chicken breeds (77.2 %), improved chicken feeds and feeding (86.7%), improved chicken housing (85.6%), chicken vaccinations (82.2%), improved chicken management (88.3%) and chicken diseases and parasites (100%). Similarly, before the respondents engage in the technology most (85.0%) of the respondents had positive perception for the technology but about 12.8% and 0.6% had negative and neutral perception, respectively. After farmers used the technology, about 95.7% of the respondent had positive perception, 0.6% had negative perception and 2.8% had neutral perception about the technology.

4.5 Sources of technology

Agricultural Office (41.1%) was the major sources of exotic chicken breeds followed by NGOs (16.3%). Agricultural Research Centres, cooperatives, farmers and private organizations were also sources of exotic and crossbred chicken breeds but their contribution was not much significant. Chicken vaccines, balanced chicken feeds, credit and poultry equipments were the major scarce technology inputs. Similarly, market support was very low; only 8.9% of the respondents got market support from agricultural cooperatives and private organizations. Most (74.4%) of the technology participants received technical support from Agricultural Offices.

Technology participants reside in the mid-altitude agro-ecology obtained ($P<0.01$) more number of day old chicks (DOs) as compared to participants reside in highland and lowland agro-ecologies (Table 2). Comparatively better quantities of DOs and pullets only (pullets without cockerels) were received per respondent across the study agro-ecologies. There was no significant difference ($P>0.05$) in the quantities of chicken forms demanded for a package program across the study agro-ecologies.

4.6 Preferred chicken breeds and forms for the technology

Bovan Brown chicken breed was the most (P<0.001) preferred chicken breed in the highland (1.7) and mid-altitude (1.9) agro-ecologies, whereas, Fayoumi was the most (P<0.001) preferred chicken breed (1.8) in the lowland agro-ecology (Table 3). Crossbred chicken preferences were not significant (P>0.05) among the study agro-ecologies. Regarding chicken forms, layers, pullets with cockerels and pullets only were the first three ranked technology forms mostly preferred by respondents (Table 4). The respondents residing in the lowland agro-ecology prefer (P<0.01) to have layers (1.6).

4.7 Adoption of technology package elements, chicken breeds and forms

Improved chicken breeds adoption was higher than adoption of the rest technology package elements. Improved chicken breeds adoption in the highland agro-ecology was statistically higher than the adoption in the mid-altitude and lowland agro-ecologies (Table 5). Respondents reside in the mid-altitude agro-ecology were better adopters of improved chicken feeds and feeding, housing, healthcare and provision of water, whereas, respondents reside in the lowland agro-ecology were least adopters. Chicken healthcare adoption was significant (P<0.05) between the study agro-ecologies. The overall technology elements adoption was not significant (P>0.05) among the study agro-ecologies.

When crude chicken breed adoption was fractionated into chicken breeds and forms, Bovan Brown chicken breed adoption was higher than other chicken breeds (Table 6). The adoption of Bovan Brown breed in the highland agro-ecology was higher (P<0.01) than the adoption in the mid-altitude and lowland agro-ecologies. Fayoumi chicken breed adoption was statistically (P>0.05) higher in the lowland agro-ecology. Similarly, when crude chicken breed adoption was fractionated into chicken forms of the technology, pullets with cockerels' adoption was better (22.2%) than the adoption of the rest chicken forms.

As shown in Table 7, most of the respondents were nil adopters (37.8%). The mean adoption index ranges from 0.28-0.38 with overall mean of 0.34. Similarly, mean adoption level ranges from 0.33-0.39 with the overall mean of 0.39. The mean adoption indexes and levels were not significant (P>0.05) among the study agro-ecologies.

5. Discussion

The age of the respondents ranged from 19-74 years. In Ethiopian, to be a member of farmer association and to obtain any agricultural technology inputs, the age of the farmer should be at least 18 years. Most of the present study respondents attended at least elementary education. This implies that educated farmers were mostly selected to participate in village poultry technology package because these people have much interest to practice improved technologies. As a whole, educated farmers were emerging in smallholder farming systems of the study areas. In agreement, majority of dairy technology participants in *Ade'a* district completed either secondary school or higher level of education (Melesse *et al.* 2013). Old farmers hold more farmland size as compared to younger farmers. About 4.4% of the respondents did not get any farmland from the *Kebele* administration. These people practiced agricultural activities either by renting farmland or by entering into an agreement with farmland owners. Less population density and availability of excess farmland were the main reasons to hold better farmland in the lowland agro-ecology, whereas, high population density and vast expansion of industries in the mid-altitude and highland agro-ecologies were the causes to have less farmland per household.

Some farmers obtained improved chicken breeds from different sources, even though farmers' demand was not satisfied yet. Most of the technology participants could not get commercial chicken rations. Mostly respondents used home available feeds and home mixed rations to supplement their chicken. However, agricultural cooperatives, Agricultural Research Centres and private organization were few sources of chicken formula feeds.

In the study areas, there were many poultry on farm trials studies; however, the contribution of agricultural researcher as source of information for village poultry technology package was very low. This indicates weak linkage of Agricultural Research Centres with farmers towards the technology. The after awareness level of the respondents to the technology showed an improvement as compared to before participating in the technology. This was in agreement with Floyd *et al.* (1999) who noted that awareness about technologies most consistently and significantly affected by extension input levels. Similarly, Okunlola (2010) reported that awareness is the first stage of adoption before the respondents develop interest in the technology and later decided on adoption.

Before farmers were engaged in village poultry technology package, some proportions of respondents have either negative or neutral perception about the technology. The reasons given by the highland and lowland agro-ecologies participants were mainly agro-ecological (1st ranked) and worry about the feasibility of the technology (2nd ranked), whereas, technology feasibility was the only main reason in the mid-altitude agro-ecology. After farmers were engaged in the technology, most had developed positive perception towards the technology, but there were still few who had either negative or neutral perception towards the technology. These before and after technology use perceptions of the respondents indicate the information gap that exist between farmer and technology, limitations and constraints of the technology, and the less effort made by the concerned authorities and institutions in popularizing the technology. Sinja *et al.* (2004) reported that the perception of farmers towards the technology characteristics affects their adoption decisions and farmer perceptions may provide a better understanding of technology adoption. Similarly, Neupane *et al*. (2002) revealed that farmers' perception of technology attributes have significant effect on the technology adoption. Understanding the farmers' perceptions towards a given technology is crucial in generation and diffusion of new technologies (Uaiene 2011). The perception of farmer about the technology can be affected by the farmer awareness and the farmer awareness can significantly influence the adoption of new technology (Oladele & Fawole, 2007; Mathialagan & Senthilkumar, 2012).

In the Ethiopian Government village poultry technology package program, mostly 5 pullets and 1 cockerel or 5 pullets only exotic or improved chicken breeds were distributed per participant. The main reasons were to address larger number of technology participants within a short period of time and to get fertile eggs either from improved chicken breeds or by crossing local and improved chicken breeds so that farmers can hatch the eggs using local broody hens. Some farmers could get improved chicken breeds from private organizations and they took more quantities of chicken forms as they could. The technology participants residing in the mid-altitude agro-ecology obtained more quantities of DOs as compared to participants residing in the highland and the lowland agro-ecologies. This might be attributable to the proximity of the district to poultry production belt areas of the country. However, most of the technology participants were not satisfied with quantities of chicken forms distributed per individual participant. There were a huge gap and mismatch between so far disseminated poultry technology quantities and the demand of the respondents.

Due to their better adaptability and productivity, Bovan Brown was the most preferred chicken breed in the highland and mid-altitude agro-ecologies, whereas Fayoumi chicken breed was the most preferred in the lowland agro-ecology. Rhode Island Red (RIR) and White Leghorn chicken breeds were the least preferred breeds for village poultry technology. The reasons most respondent presented were that RIR breed is very adaptable to the agro-ecologies but their eggs have hatchability problem when set by local broody hens. In agreement, Mulugeta (2006) reported that RIR chicken eggs have poor fertility and hatchability under natural incubation. The reason for the poor fertility and hatchability of eggs from this breed under natural incubation has not been reported so far. This might be the main reason why village poultry technology of the country shifted to Bovan Brown chicken breed. Respondents said that White Leghorn chicken breed is easily attacked by predators and diseases.

Hot weather stress during the month of May and disease outbreaks (mainly Newcastle disease) were the major problems that influenced chicken breeds adoption in the lowland agro-ecology, whereas, cold weather stress during cold season (July to October) and long time to first egg production were main problems that influenced adoption in the highland agro-ecology. Generally, the overall improved chicken breeds adoption (40.6%) of this study was comparable with the finding of Teklewold *et al*. (2006), who noted that about 41.5% of the smallholder farmers adopted exotic chicken breeds in east Shewa and Welayeta zones of Ethiopia. Similarly, comparable chicken breeds adoption (43.48%) was reported by Khandait *et al.* (2011), in backyard poultry rearing in Bhandara district of India. These indicate that chicken breeds adoption under village poultry production systems might be influenced by common factors regardless of geographical location. Respondents found in the mid-altitude agro-ecology were better adopters' of chicken healthcare. This might be due to the proximity of the district to National Veterinary Institute (NVI) and National Poultry Research Coordinator Centre (Debrezeit Agricultural Research Centre). Moreover, the district is located in the area of the country designated as poultry production belt areas, and the participants may be directly or in directly benefited from the activities conducted by stakeholders to promote poultry production and technology transfer.

The adoption levels of technology elements were variable across the study agro-ecologies. The overall mean adoption level of the technology elements across the study agro-ecologies was 39.4%. Better adoption (48.3%) was found in the highland agro-ecology and the least (33.3%) in the lowland agro-ecology. As compared to this study, better poultry technology elements adoption levels; chicken housing (49.7%), chicken feeding and watering (59.17%), chicken healthcare (27.44%) and overall adoption levels of 49.28% were reported in backyard poultry rearing in Bhandara district of India (Khandait *et al*. 2011). According to Feder *et al.* (1985) and Chebil *et al.* (2009), farmers will adopt new technologies when they expect more profitable outcome will be gained from the new technology than that previously existing activity or if the expected utility obtained from the new technology exceeds that of the old one. So far, there was no study reported on the adoption level of village poultry technology elements in Ethiopia to compare with the current study. However, according to Jain *et al*. (2009) the extent of adoption of new agricultural technologies can be mainly determined by the area and use of various inputs. Similarly, socio-personal and economic characteristics can affect the adoption of the technology (Rahman 2007).

Regarding chicken breeds and forms adoption, the better adaptability of Fayoumi chicken breed to the lowland agro-ecology, easiness of their management and better egg productivity under smallholder production system made the respondents to adopt this breed type. However, since the breed has light weight, when they are culled from the production systems, no one can buy them for meat consumption.

Forms of chicken breed technology adoption were a factor of technology affordability, accessibility, and immediate income source, easiness of the management and profitability of the technology forms. A farmer might have two or more chicken breeds in his/her production system and could practice two or more technology forms. As a result, the respondent might adopt one or more chicken breeds and forms. Pullets with cockerels adoption was better (P>0.05) than the rest of the technology forms. The main reasons were, this technology form was mostly distributed to farmers and farmers believe that if there is cockerels with pullets, pullets will come into first egg production shortly and the presence of cock with layers stimulate layers for more egg production. These believe of farmers needs further study. Fertile eggs technology form was the second better adopted technology form. This was due to affordability and easily availability of fertile eggs in village poultry production systems, and availability of local broody hen to set eggs and to replace their flock.

Generally, based on the computed overall mean adoption index and level, the village poultry technology package participants were categorized under low adopters. In agreement, Quddus (2012) reported that dairy technology practicing respondents who had less 0.35 adoption index are categorized under low level of adopters. Similarly, based on the level of improved pig technologies adoption, Rahman (2007) and Zanu *et al.* (2012) categorized respondents having AI up to 0.33 into low adopters.

On focus group discussion, it was found that Agricultural office, cooperatives, farmers, NGOs and private organizations were key actor of the technology. They networked or communicated each other mostly though agricultural development agents. Sometimes they communicated through meeting and model farmers but their communication through discussion forum and regular visit were very weak. The linkage among the actors was weak. This weak network system was one factor that affects the adoption level of the technology. Moreover, the participants ranked technology inputs scarcity (1st rank) and high cost of technology inputs (2nd rank) of major factors that affect the adoption of the technology followed by chicken health problem (3rd rank).

6. Conclusion

From this study, it can be concluded that Agricultural Office and NGOs were major sources of exotic chicken breeds for the technology package, even though the demand of the technology participants was not satisfied so far. Balanced chicken rations, vaccines, credit, poultry equipments and market support were the major limited inputs and services of the technology.

There was a huge gap between the quantities of chicken forms distributed and the quantities demanded by the technology participants. The overall village chicken technology adoption level in the study agro-ecologies was categorized under low level category. Therefore, to improve the adoption status of the technology, much effort will be needed from Governmental Organizations, Agricultural Research Centres, NGOs and Private Organizations, small-scale chicks growing centres, professionals and famers.

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Table 1: ***Socio-economic characteristics of the respondents***

Variable	Agro-ecology			Range	Overall mean	F value	Pr > F
	Highland	Mid-altitude	Lowland				
Age (year)	40.7(1.30)	41.4(1.51)	44.3(1.16)	19-74	42.1(0.77)	2.09	0.1266
Family size	5.8(0.33)	5.8(0.30)	6.4(0.28)	1-12	6.0(0.18)	1.34	0.2632
Annual income (1000 Birr)	37.0(0.49)[b]	66.8(0.76)[a]	62.3(0.73)[a]	7-250	55.8(0.41)	3.17	0.0445
Landholding per household (ha)	1.8(0.18)[b]	1.5(0.16)[b]	2.6(0.25)[a]	0-7	2.0(0.11)	8.69	0.0003
Chicken farming experience (year)	19.4(1.40)	21.0(1.38)	22.0(1.11)	5-58	20.8(0.75)	0.98	0.3790

Birr= Ethiopian currency; ha= hectare; values in the parenthesis are standard errors; means in the row with the same letter are not significantly different.

Table 2: ***Quantities of chicken technology forms received and demanded per participant per a program***

Chicken forms	Agro-ecology			Overall mean	F value	Pr>F
	Highland	Mid-altitude	Lowland			
Quantities received						
Fertile eggs	0.26(0.20)	1.4(0.67)	1.3(0.46)	1.0(0.28)	1.7	0.1905
DOs	16.8(4.44)[b]	34.0(9.20)[a]	3.7(1.60)[b]	18.2(3.55)	6.5	0.0019
Pullcocker	4.2(1.11)	5.5(1.83)	4.3(1.14)	4.7(0.80)	0.30	0.7492
Pullets only	8.4(2.89)	14.9(6.91)	6.9(0.65)	10.1(1.25)	1.0	0.3819
Layers	9.6(8.41)	0.6(0.25)	0.5(0.24)	3.6(2.81)	1.2	0.3187
Quantities demanded						
Fertile eggs	13.0(1.69)	10.5(2.21)	11.3(1.82)	11.6(0.99)	0.56	0.5708
DOs	203.9(40.87)	218.7(53.75)	88.0(31.69)	170.2(22.17)	2.72	0.0694
Pullcocker	79.6(23.26)	65.1(12.75)	47.3(8.04)	64.0(6.11)	0.94	0.3940
Pullets only	109.3(30.97)	124.5(42.91)	59.7(19.99)	97.9(16.27)	1.07	0.3468
Layers	91.8(23.87)	93.6(42.36)	42.5(7.86)	76.0(14.04)	1.08	0.3423

Dos= day old chicks; Pullcocker= Pullets with cockerels; values in the parenthesis are standard errors; means in the row with the same letter are not significantly different.

Table 3: ***Chicken breeds prefer by respondents (1= Most preferred; 5=Least preferred)***

Breed type	Agro-ecology			F value	Pr>F
	Highland	Mid-altitude	Lowland		
Rhode Island Red	4.2(0.17)[b]	4.9(0.09)[a]	4.7(0.14)[a]	5.17	0.007
Bovan Brown	1.7(0.16)[b]	1.9(0.14)[b]	2.5(0.18)[a]	7.66	0.001
White Leghorn	3.4(0.18)[b]	4.0(0.17)[a]	4.3(0.16)[a]	6.76	0.002
Fayoumi	4.2(0.18)[a]	3.5(0.21)[b]	1.8(0.13)[c]	46.82	0.000
Crossbred	2.7(0.19)	2.3(0.17)	2.6(0.15)	2.03	0.134

Values in the parenthesis are standard errors; ranked means in the row with the same letter are not significantly different.

Table 4: ***Chicken forms prefer by respondents to obtain in the future (1= Most preferred; 5=Least preferred)***

Forms	Agro-ecology			F value	Pr>F
	Highland	Mid-altitude	Lowland		
Fertile eggs	4.6(0.08)	4.5(0.09)	4.7(0.08)	1.15	0.319
Day old chicks	3.3(0.18)	3.4(0.15)	3.9(0.10)	2.91	0.057
Pullets only	2.6(0.14)	2.6(0.12)	2.8(0.12)	1.16	0.316
Pullets with cockerels	2.4(0.14)	2.1(0.13)	2.1(0.11)	2.05	0.132
Layers	2.0(0.13)[a]	2.2(0.16)[a]	1.6(0.11)[b]	6.05	0.003

Values in the parenthesis are standard errors; ranked means in the row with the same letter are not significantly different.

Table 5: ***Adoption level of poultry technology package elements across the study agro-ecologies***

Technology element adopters	Agro-ecology			Overall	χ^2	P-value
	Highland	Mid-altitude	Lowland			
Chicken breeds adopters (%)	31(51.7)	20(33.3)	22(36.7)	73(40.6)	4.7	0.093
Feeds and feeding adopters (%)	16(26.7)	22(36.7)	15(25.0)	53(29.4)	2.3	0.317
Housing adopters (%)	21(35.0)	25(41.7)	15(25.0)	61(33.9)	3.8	0.152
Healthcare adopters (%)	11[ab](18.3)	18[a] (30.0)	7[b](11.7)	36(20.0)	6.5	0.040
Water provision adopters (%)	22(36.7)	25(41.7)	16(26.7)	63(35.0)	1.9	0.386
Overall elements adopters (%)	29(48.3)	22(36.7)	20(33.3)	71(39.4)	3.1	0.210

Numbers outside and inside parenthesis represents respondent number and percentage, respectively; values in the row with the same letter are not significantly different.

Table 6: ***Adoption levels of chicken breeds and forms across the study agro-ecologies***

Adoption	Agro-ecology			Overall (%)	χ^2	P-value
	Highland	Mid-altitude	Lowland			
Breeds adopted						
Bovan Brown	25[a](41.7)	11[b](18.3)	11[b](18.3)	47(26.1)	11.3	0.004
Fayoumi	5(8.3)	3(5.0)	8(13.3)	16(8.9)	0.14	0.934
Crossbred	10(16.7)	8(13.3)	12(20.0)	30(16.7)	0.24	0.887
Forms adopted						
Fertile eggs	7(11.7)	4(6.7)	11(18.3)	22(12.2)	0.73	0.696
Day old chicks	4 (6.7)	6(10.0)	7(11.7)	17(9.4)	0.13	0.937
Pullets with cockerels	17(28.3)	9(15.0)	14(23.3)	40(22.2)	0.84	0.658
Pullets only	2(3.3)	8(13.3)	5(8.3)	15(8.3)	0.44	0.804
Layers	9[a](15.0)	5[b](8.3)	2[b](3.3)	16(8.9)	12.49	0.002

Numbers outside and inside parenthesis represent respondent number and percentage, respectively; values in the row with the same letter are not significantly different.

Table 7: ***Adoption levels and index categories of the respondents across the study agro-ecologies***

Adoption level category	Adoption index Category	Frequency (%)			Overall (%)
		Highland	Mid-altitude	Lowland	
Nil	0	21(35.0)	23(38.3)	24(40.0)	68(37.8)
Very low	>0 up to 0.20	1(1.7)	4(6.7)	7(11.7)	12(6.6)
Low	0.21 to 0.40	13(21.7)	6(10.0)	10(16.7)	29(16.1)
Medium	0.41 to 0.60	10(16.7)	11(18.3)	9(15.0)	30(16.7)
High	0.61 to 0.80	7(11.7)	0(0.0)	9(15.0)	16(8.9)
Very high	> 0.80 to 1	8(13.3)	16(26.7)	1(1.7)	25(13.9)

Numbers outside and inside parenthesis represents respondent number and percentage, respectively.