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Intention to adopt improved indigenous chicken breeds among smallholder farmers in Machakos county, Kenya. Do socio-psychological factors matter?

Christopher N. Kamau [a,*], Eucabeth B. Majiwa [b], Geoffrey O. Otieno [b], Lucy W. Kabuage [c]

[a] *Department of Agricultural Economics, Kenyatta University, P.O BOX 43844, 00100, Nairobi, Kenya*
[b] *Department of Agricultural and Resource Economics, Jomo Kenyatta University of Agriculture and Technology, P.O BOX 62000, 00200, Nairobi, Kenya*
[c] *Department of Animal Sciences, Kenyatta University, P.O BOX 43844, Nairobi, Kenya*

A R T I C L E I N F O

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A B S T R A C T

Consumption of poultry meat, eggs, and other animal-sourced commodities has dramatically risen by almost 86 %, with the demand of indigenous chicken products almost doubling over the past few decades. In Kenya, poultry farmers prefer indigenous chicken (IC) due to their resilience to harsh climatic conditions, high feed conversion rates, delicious end products, ability to scavenge and potential to reduce greenhouse gas emissions among other factors. Despite the high demand for poultry and its products, the gap between demand and production remains high. Poultry farmers try to keep pace with the demand by integrating the recommended improved IC breeds into their production system. Although there exists some understanding on the determinants of the farmers to adopt improved IC, still there is scanty information on how socio-psychological factors influence the intention to adoption improved IC among the farmers in Kenya. Thus, this study sought to investigate the determinants of intention to adopt improved IC while specially focusing on the role of socio-psychological factors. A total of 374 IC farmers in Machakos county were selected using a multistage sampling technique. Partial Least Square - Structural Equation Modelling (PLS-SEM) was employed to analyze the data. Results from descriptive statistics showed that approximately 90 % of IC farmers in the study area were aware of the improved indigenous chicken breeds. However, the adoption of the improved IC was below average (44.9 %). The path analysis results revealed that Subjective Norm (SN) was the main determinant of farmer's intention to adopt improved IC breeds, followed by Attitude (ATT) and Perceived Behavioral Control (PBC). The study recommends more emphasis to be given to psycho-social issues through well designed public and private interventions that will promote adoption of improved breeds among IC farmers.

1. Introduction

Animal-source proteins particularly poultry meat and eggs remain the most commonly consumed foods globally of which at least

* Corresponding author.
E-mail address: chricat89@gmail.com (C.N. Kamau).

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33 % of meat is poultry[1]. The consumption of poultry meat, eggs, and other animal-sourced commodities has dramatically risen by almost 86 %, or 3 % since 2001 with the demand of indigenous chicken almost doubling over the past few decades (Food and Agriculture Organization of the United Nations, 2021). The global consumption of poultry meat is thus predicted to account for 41 % of all proteins obtained from animal sources by the year 2030 [2]; [3]; [4]. Growth in per capita consumption in both developed and developing countries is expected to increase with the poultry subsector anticipated to account for 44 % share of the total meat output globally[5]. The aggregated global meat consumption in the world is also expected to rise by 1.1 kg retail weight equivalent (r.w.e) with poultry accounting for 0.8 kg r. w.e by year the 2027 (OECD/FAO, 2019). Increased human population, high rate of urbanization, health consciousness, and rising average disposable income have been linked to the growth in consumption [6]; The [7]. It is projected that 68 % of the world population will be living in urban areas by 2050 triggering further demand for more poultry products (United Nations, 2017). Projections also indicate that consumption of white meat in most developing countries such as Kenya will surpass red meat (OECD/FAO, 2018). The current state of world consumption calls for more attention towards poultry production, given the anticipated increase in meat consumption from 134 million tonnes to 152 million tonnes (MT) by the year 2030 ([3]; [5].

In Kenya, chicken is estimated to constitute 98 % of the poultry population with the remaining proportion (2 %) accounting for other types of poultry namely; ostrich, doves, quail, geese, guinea fowls, and turkey (RoK, 2019). Chicken dominates in the poultry sector with indigenous chicken (IC) constituting 70 % of the total poultry population (RoK, 2019; [8]. 80 % of households living in rural areas rely on IC to bridge some of the precautionary demand for finances[9]. Venturing into IC production has also proved beneficial through the provision of employment and more so to vulnerable groups such as women, youths, and people living with disabilities (Food and Agriculture Organization of the United Nations [10], 2015; [11]. Further, IC production provides an avenue toward poverty reduction as well as mitigating food insecurity in developing countries through increased food production[1]. Indigenous chicken is preferred by farmers due to their ability to scavenge, high feed conversion efficiency, high survivability rate even in harsh environments, and their quality products[12,13]. Rearing of IC would therefore provide a solution towards the reduction of agricultural climatic shocks among the smallholder farmers in dry areas, hence achieving resilience[14,15]. As well, studies have documented the potential of IC to minimizing greenhouse gases emission as compared with other types of livestock[11,16].

There exists an unmet demand for IC products (meat and eggs) despite the projected country population of 96 million people by the year 2050 [15,17]. Some of the setbacks experienced in IC production include; low genetic potential, diseases, and chick's mortalities, just to mention a few, hence leading to low productivity [12,18]. The aforementioned scenario calls for transformative processes such as the integration of improved IC production technologies in an attempt to bridge the production gap ([19] [5]; ROK, 2019; [17]. In the last few years, agricultural stakeholders have been at the forefront of the promotion of improved IC breeds such as KALRO improved chicken, Sasso, Kuroiler, etc. The breeds are dual purpose with higher potential of productivity and mature faster as compared with the local IC ([20]). Despite the various activities to achieve the expected output by the stakeholders, information on the process of adoption of improved IC breeds remains scanty. Few efforts have been made in light of the psychological aspects that tend to influence farmers' intention to embrace agricultural technologies, with more attention being paid to socioeconomic features to document diverse adoption determinants. Understanding the psychological factors can influence whether or not farmers are motivated to use new agricultural technology. Failure to incorporate the aspect of psychological drivers may limit a comprehensive understanding on farmer's intention to adopt agricultural technologies (Zeweld et al., 207; [21]. Previous research in different agricultural contexts affirm intention as a key predictor of behavior towards the adoption of agricultural technologies among smallholder farmers[22–24].

Researchers support that use of the Theory of Planned Behavior (TPB) as proposed by Ref. [25] can adequately predict farmers behavioral intentions as compared to the Theory of Reasoned Action (TRA). Use of TRA model limits full prediction of farmers behavior since it fails to incorporate the crucial role of the perceived behavioral control (Borges et al., 2014; [22]. For example, the TPB framework has been used to shed light on understanding farmers intention towards adoption in diverse agricultural context such as; aquaculture innovations [23], sustainable agricultural practices (Mutysira et al., 2018), tree planting [26], improved natural grassland (Borges et al., 2014), common beans production [27], and on mixed cropping [28]. However, there is paucity of information on understanding IC farmers intention to adopt improved IC. The study therefore sought to determine the psychological factors influencing smallholder farmers' intentions to adopt improved IC breeds in Machakos county. According to the TPB framework, smallholder IC farmers are more likely to adopt improved breeds if they; regard them for better performance, perceive a normative social pressure to adopt, and express their capability of adopting them. The study therefore contributes theoretically to confirm on the suitability and applicability of the TPB model at predicting farmers behavior to adopt improved IC breeds. As well, the finding enables authors suggestions towards policy development in the poultry sector that seek to favor or deter farmers intention to adopt improved IC breeds.

2. Analytical frameworks

2.1. Conceptual framework

Agricultural technology uptake is driven by a series of connected internal and external determinants[29]. Agricultural knowledge transfer and adoption may be influenced by the degree of awareness and expertise, which in turn may affect the performance of technology[30]. However, awareness and knowledge are bundled together or used interchangeably in most instances and viewed as preconditional to the use of a given technology or collection of technologies[31]. Different sources of contemplation are also explored in the study, such as extension, diverse pathways, and relationships with other individuals[32]. Technological uptake can be bivalent, based on the training status of a farmer's household, and are likely to cause a difference in performance[31]. Moreover, successful adoption rates and narrow gaps between potential adoption and actual adoption are preceded by high awareness levels of agriculture technologies[33].

Smallholder farmers develop attitudes based on behavior costs towards agriculture technology that affect the likelihood of adoption and performance[34]. Perception is determined by the awareness of technology, the interaction of the farmer with other sources of information within and outside the farms[35]. Knowledge and attitude determine the extent of adoption of agriculture technology but are in turn influenced by other contextual factors such as farm sizes[36]. The sequence in which perception, awareness, and knowledge are organized may ultimately have a substantial effect on performance metrics such as yields and earnings. Perceptions do not necessarily convert into the adoption of new technology, since there are a variety of intervening elements that can help or impede the adoption process[32]. However, in cases where adoption occurs farmer's intentions and norms in the society should also be considered alongside socioeconomic characteristics[37]. The perception of adopters on technology is affected by prevailing government policy, practicality or applicability of technology, access to information, and performance of technology[38].

Extension services, which may be an intervening or driver variable, shapes smallholder farmers' perceptions and attitudes, which in turn influence productivity and earnings[39,40]. In most instances, extension contact is the preferred proxy for attitudes and perceptions, considering the challenges inherent in the disaggregation of awareness and knowledge[41]. Furthermore, extension services influence the risk and perception among smallholder farmers, which determines the adoption of technology[42]. Performance of extension services affects the innovation levels and individual perception, which include economic, hedonistic, and self-achievements [40,43]. However, it is also evident that the mode of extension delivery, alongside service provider biases, may affect the perception of new technology and the adoption[44]. Adoption of an improved agricultural technology based on the impression, has a favorable effect on the performance of various agricultural operations of the adopters towards new technology or technological sets[45]

2.2. Theoretical framework

This study utilizes the Theory of Planned Behavior (TPB) framework to understand farmer's intention to adopt improved IC. The TPB framework was first developed by Ref. [25] in an attempt to provide more insight into analyzing the farmer's intentions to behave in a given situation thus categorized under social cognitive theory [25]. asserts that intention can be evaluated using 3 constructs which include; attitude towards the behavior (ATT), subjective norm (SN), and perceived behavioral control (PBC). Intention can be defined as the probability of an individual engaging in a particular behavior that is influenced by salient beliefs[46]. Consequently, stronger individual intentions will increase the likelihood of performing a particular behavior[25]. In the context of this study, intention refers to the extent to which farmers are motivated to improved poultry production technologies [47]. affirmed that attitude which forms the first construct expresses how well an individual perceives a behavior which in this case can be favorable or unfavorable. Therefore, the attitude construct remains a key determinant of an intention that further informs immediate behavior[48,49].

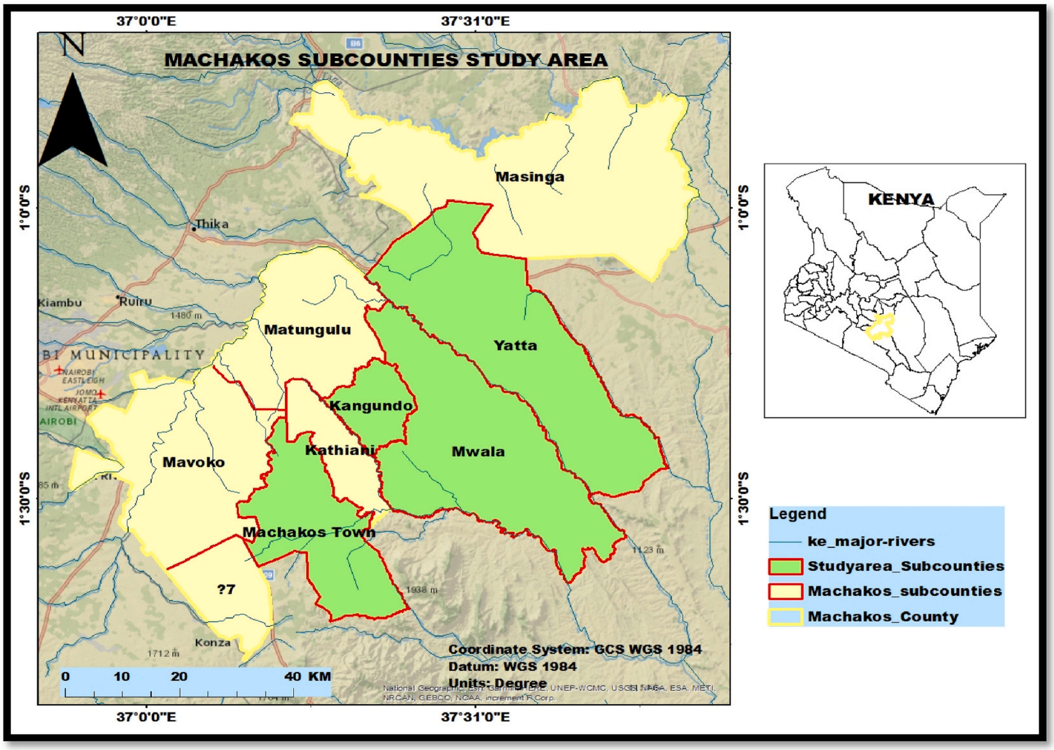

Fig. 1. Map of the study area.

Again, in his framework [25], reported that social norms originate from social pressures which in this case influence an individual to act in a specific manner. Some of the sources of the social pressure include; groups of individuals, close friends, and family members. Studies have reported social norms to have got a positive influence on behavioral intention[24,50]. Lastly, perceived behavior control is defined as an individual's perception of his capability to successfully execute the behavior[51]. However, the perception is mainly limited by the scarcity of individual resources such as knowledge, ability, capital, technology, etc[52]. In the context of this study, farmers would have a higher intention to produce more chicken under their systems when they evaluate improved poultry production technologies as more favorable (attitude), when they perceive social pressure to use these technologies to be higher (subjective norm), and when they have more positive beliefs about their capability to use the technologies (perceived behavioral control). Therefore, the use of TPB theory will enable the prediction of the intention and behavior concerning the use of the improved poultry production technologies among smallholder IC farmers.

3. Material and methods

3.1. The study area

The study was conducted in Machakos County (Fig. 1) which constitutes the lower Eastern region of Kenya. The county lies between Latitude 0°45′South and 1°31′South and longitudes 36°45′ East and 37°45′ East (RoK, 2013). It has a total coverage area of 6208.2 Km^2. The county is composed of 9 sub-counties, namely Athi River, Kalama, Kangundo, Kathiani, Machakos, Masinga, Matungulu, Mwala and Yatta (KNBS, 2019). The distribution of population in the county is estimated at 1,421,998 (with 710,707 and 711,191 for male, and female, respectively (a ratio of almost 1 is 1). The population density is 235 per Km^2 with good road networks traversing across the county[53]. Agriculture serves as the main economic activity being practiced in the county with livestock dominating the sector (CIDP, 2018). However, the adverse effect of climate change has been a major setback on agricultural production in the county[54]. The temperature fluctuates between 18 °C to 29 °C with a bimodal rainfall pattern that reaches a maximum of 1250 mm and a minimum of 500 mm (CIDP, 2018). The main agro-ecological zones (AEZ) in the county resemble arid and semi-arid land with very low to moderate precipitation amounts and adequacy (CIDP, 2018; RoK, 2019).

3.2. Data collection and sampling procedure

The study adopted a multi-stage stratified sampling technique. Purposive sampling was applied to select Machakos County, which is one of the leading indigenous chicken-producing counties in the Lower Eastern region of Kenya. It is estimated that a proportion of 62 % of households in Machakos County produce indigenous chicken[53]. The second stage used stratified random sampling to select the sub-counties within Machakos County namely; Kangundo, Mwala, Yatta, Machakos. Random stratified sampling was preferred in an attempt to reduce the biases associated with sampling. This approach catered for the over-representation or under-representation of the smallholder farmers in different strata. Subsequently, random sampling was executed to select a total of 374 households to be interviewed during the research. The data collection process was voluntary and informed consent was sought from the farmer before conducting an interview. Primary data was collected using a structured questionnaire, checklist, key informant interviews, focused group discussion, and direct observations. Secondary data was obtained from the County Agricultural Offices, Department of Livestock Production Offices of Machakos County to supplement the primary data.

Table 1
Statements to measure the psychological constructs on improved IC breeds.

Construct	Measuring Item	Mean	Std. Err
Attitude (ATT)		**4.07**	**0.03**
$ATT1_{IIC}$	I think improved IC matures faster compared to local IC	4.07	0.04
$ATT2_{IIC}$	I think IIC increases meat production as compared to local IC	3.96	0.04
$ATT3_{IIC}$	I think IIC increases egg production as compared to local IC	4.19	0.03
$ATT4_{IIC}$	I think IIC increases farm income as compared to local IC	4.04	0.03
Subjective Norms (SN)		**3.78**	**0.03**
$SN1_{IIC}$	My family members think I should rear IIC on my farm	3.90	0.03
$SN2_{IIC}$	My friend's members think I should rear IIC on my farm	3.85	0.04
$SN3_{IIC}$	Other farmers think I should rear IIC on my farm	3.84	0.03
$SN4_{IIC}$	The government extension officers think I should rear IIC in my farm	3.51	0.04
Perceived Behavioral Control (PBC)		**3.55**	**0.05**
$PBC1_{IIC}$	I feel that I have sufficient knowledge and skills on rearing IIC in my farm	3.58	0.05
$PBC2_{IIC}$	I have all the resources required to rear IIC in my farm	3.40	0.06
$PBC3_{IIC}$	If I want to rear IIC in my farm, I have enough technical skills	3.67	0.05
Intention (INT)		**3.98**	**0.03**
$INT1_{IIC}$	I would recommend the IIC adoption for other IC farmers in my area	4.04	0.03
$INT2_{IIC}$	I have plans to adopt improved IC in the next 5 years	4.01	0.03
$INT3_{IIC}$	I have plans to further develop improved IC flock size within a year	3.90	0.04

Source: *Survey, 2022*

3.3. Data and analytical framework

3.3.1. Statistical analysis

Statistics were performed using several steps. First, authors employed descriptive statistics to shed light on the characteristics of the surveyed households in the study area. Some of the socioeconomic characteristics included, age of the household head, level of education, family size, dependency ratio, land size in acres, years of experience in poultry production, total flock size, total livestock holdings, distance to the tarmac road and the total number of extensions accessed in the last one year of study period. Proportions were also used to quantify the status of the few binary variables (*yes = 1, otherwise 0*) such as awareness and decision to adopt improved IC breeds in the study area. Subsequently, the authors described the main features of the direct measures to represent the TPB constructs. A set of 14 variables representing the four psychological constructs—attitude (ATT), subjective norm (SN), perceived behavioral control (PBC), and intention (I) — were measured using a five-point Likert scale 1 - "strongly disagree", 2 - "disagree", 3 – "neutral", 4 – "agree", and 5 - "strongly agree"). In this study, items presented in Table 1 were derived from the prior farmers adoption literature and therefore used as reflective indicators for each construct.

3.3.2. Validation of measurements

Using the two-step approach (PLS-SEM), the study combined both factor analysis (FA) and ordinal least square method (OLSM). A factor analysis was used to obtain a satisfactory measurement model whereas an OLSM enabled the development and testing of the structural model using the Goodness of fit indices. In the first step, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were executed to determine whether the sampling was adequate. The measurement model assessment was based on the following indicators; firstly, a multiple collinearity assumption was carried out to cater for redundancy in the measurement model. A construct validity included both convergent and discriminant validity. Convergent validity assessed the on the following indicators; Standard Factor Loadings (SFL), average variance extracted (AVE) and, composite reliability (CR). According to Borges and Lansink, (2016), the AVE derived from the four constructs should supersede the squared inter-construct correlation. As well, a discriminant validity (DV) was executed Fornell–Larcker Criterion to check on the conformity of the constructs. After obtaining a suitable measurement model, the confirmatory factor analysis (CFA) was also employed to examine the overall goodness of fit thus a test on fitness of the theory with the data using OLSM. A total of seven conventional model-fit were adopted, namely, Chi-Square ($\chi 2$), Root Mean Squared Error of Approximation (RMSEA), Pclose, Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Coefficient of Determination, and Standardized Root Mean Squared Residue (SRMR).

3.3.3. Econometric model specification and estimation procedure

The Theory of Planed Behavior (TPB) framework helped in identification of key drivers of the three latent constructs (Attitude, Social Norm, and Perception Behavioral Control) hence quantify farmer's behavior in terms of intention. The Partial Least Square-Structural Equation Modelling does not assume the distribution of data (robust to non-normal data), maximizes the explained variance, and further minimizes the general error term[55,56]. Studies have employed this model at assessing farmer's intention which is a function of behavior[22,27,37]. The model has been preferred for its applicability given a variety of behaviors under different contexts. Empirically, the relationship between intention and behavior can be expressed as shown in equation (1);

$$\text{Intent (I)} = \beta_1 \text{Att} + \beta_2 \text{SN} + \beta_3 \text{PBC} + \mu \tag{1}$$

where $\boldsymbol{\beta}$ = empirically estimated path coefficients showing the relative for each of the constructs; and $\boldsymbol{\mu}$ represents the disturbance term. Other abbreviations are as follows; Attitude (Att), SN (Subjective Norms), and Perceived Behavior Control (PBC).

The psychological drivers were analyzed using a Partial Least Squares regression - Structural Equation Modelling (PLS-SEM) which is a variance-based approach. The approach allows for simultaneous estimation of the outer (indicators on the latent construct) and inner model (path coefficient between the latent constructs). All the constructs were defined as reflective measurements that intend to reveal the relationship from the latent construct to its measured indicator variables, and measurement errors that are accounted for at the indicator level[57]. In this case the estimated reflective outer model for an exogenous latent construct $\boldsymbol{\xi}$ can be expressed using equation (2) below;

$$\mathrm{x} = \lambda \mathrm{x} \xi + \mu \mathrm{x} \tag{2}$$

where $\mathbf{x}$ represents the vector of the measured indicator variables; $\boldsymbol{\lambda}\mathbf{x}$ refers to the vector of the outer loadings; and $\boldsymbol{\mu}\mathbf{x}$ is the disturbance term to account for the unobserved variance. Likewise, the reflective outer model for an endogenous (constructs aimed to be explained by the inner model) latent construct can be estimated using equation (3);

$$\mathrm{z} = \lambda \mathrm{z} \xi + \mu \mathrm{z} \tag{3}$$

where $\mathbf{z}$ represents the vector of the measured indicator variables; $\boldsymbol{\lambda}\mathbf{z}$ refers to the vector of the outer loadings; and $\boldsymbol{\mu}\mathbf{z}$ is the disturbance term to account for the unobserved variance. Hence, the inner model (estimates path coefficients between two endogenous constructs or between exogenous and endogenous constructs) is denoted as shown in equation (4) below;

$$\eta = B\eta + \Gamma \xi + \zeta \tag{4}$$

where the vector of the endogenous constructs is denoted by $\boldsymbol{\eta}$ represents; $\mathbf{B}$ and $\boldsymbol{\Gamma}$ refers to the path coefficient matrices for the causal effects form the endogenous **(η)** and exogenous construct (ξ); and ζ represents the residuals for the inner model.

3.3.4. Hypothesis testing

Psychological drivers are unobservable variables and use of multiple observed statements was considered during measurements. It was expected that the exogenous latent variables would have an influence on endogenous latent variables and therefore the three hypotheses motivating the intention to the actual behavior were proposed as follows:

Hypothesis 1. The attitude (ATT) has a positive effect on farmers' intention to adopt improved IC breeds.

Hypothesis 2. The subjective norms (SN) have positive effect on farmers' intention to adopt improved IC breeds.

Hypothesis 3. The perceived behavioral control (PBC) has positive effect on farmers' intention to adopt improved IC breeds.

4. Results and discussion

4.1. Descriptive statistics

The mean age of the household head was 52 years. The average number of years corresponds with the active years for many smallholder farmers in Africa. The majority of the households had attained primary and secondary school education with an average of 11 years of schooling. Thus, the majority of the interviewed household heads could read and write. Results revealed an average of 5 persons per household. The dependency ratio was above average (79 %) and this clearly shows that the majority of households had people who were actively engaged in the labor force. The average size of land per household was 2.42 acres, which was fairly small. This reflects the typical parcel of land owned by a smallholder farmer in the majority of developing nations. However, the farm size is below expectations given the nature and classification of the county as an arid and semi-arid land (ASAL). The majority of the farmers had an acceptable amount of experience because they had been raising chicken for a long time—roughly 12 years, according to the findings. Given that the county is well-known for producing local chicken in Kenya, the situation is conceivable (Supplementary Table 1).

The average flock size per family was 39 indigenous chickens. It is important to note that farmers in the research area also kept other types of livestock, and the World Bank's multiple indexes were utilized to calculate the tropical livestock unit. The average livestock density found in the result was 2.44, and this was sufficient as a diversification strategy for livestock development. To access tarmac roads, which are a representation of improved infrastructure in the research area, households traveled for about 19 min to access the nearest weather roads. Additionally, in the last year of the reporting period, farmers had an average of two contacts with the extension service providers. Studies have also emphasized on significance of awareness because it is suggested that, it is still a requirement for farmers to adopt a certain technology[58,59]. Different degrees of awareness among smallholders have been connected to the availability of various informational channels, including field trips, access to extension services, membership in agricultural associations, experiments, and other networks. Results revealed that 89.8 % were aware of the improved IC (Supplementary Table 2). Despite widespread awareness, only 44.9 % of the households had adopted the improved IC breeds in the study area.

4.2. Psychological drivers of Farmer's intention to adopt improved IC breeds

The items used to evaluate each component on improved chicken breeds are listed in Table 1.

Results on descriptive statistics revealed that responses were generally higher than the "neutral" value of 3 for all the constructs. Findings showed that the respondents are moderately positive on PBC and SN with an average of 3.55 and 3.78, respectively. Similarly, they have a positive attitude (4.07) towards adoption of the improved IC breeds.

Table 2
Convergent validity of the measurement model (MM) for improved IC breeds.

Construct	Items	Factor Loadings (FL)	Composite Reliability (CR)	Average Variance Extra (AVE)	Cronbach α (Alpha)
Attitude	2	**0.819**	**0.786**	**0.484**	**0.7182**
	1	0.743			
	4	0.634			
	3	0.559			
Subjective Norms	3	**0.824**	**0.843**	**0.575**	**0.8408**
	2	0.819			
	1	0.709			
	4	0.669			
Perceived Behavioral Control (PBC)	1	**0.827**	**0.750**	**0.649**	**0.7859**
	2	0.809			
	3	0.780			
Intention	2	**0.818**	**0.825**	**0.611**	**0.7934**
	3	0.767			
	1	0.758			

Source: *Model Output, 2022*

4.3. Exploratory factor analysis for improved IC breeds

Results validated eligibility for additional factor analysis since the value of KMO was larger than 0.05 (p-value<0.05; Supplementary Table 3). The null hypothesis H_0 in this case was rejected. The KMO (0.828) was above the recommended threshold of 0.7 [60,61]. A satisfactory measurement model was confirmed using different metrics at every stage. The study adopted the factor loadings (FL), and Cronbach Alpha (denoted by **α)** to assess items and constructs on reliability. Findings revealed that all the factor loadings used in the study were greater than 0.5 as suggested by Ref. [62]. This confirmed the strong relationship between the observed indicators and the associated constructs. The most influential factor for attitude (ATT) was ATT_2 (F.L; 0.819), i.e., improved IC breeds increases meat production as compared to local chicken. For subjective norm (SN), the factor loading of SN_3 (F.L; 0.824) was the highest among other items. This suggested that the inclination of these IC farmers to adopt the improved IC breeds was most influenced by other IC farmers. The Perceived Behavioral Control (PBC_1 (F L; 0.827) had the highest score within the construct. This was done because farmers believed they had the knowledge and expertise necessary to raise superior breeds on their farms.

Table 2 provides convergent tests conducted on each construct. They include, Standard Factor Loadings (SFL), Composite Reliability (CR), Cronbach Alpha, and Average Variance Extracted (AVE). The values on factor loadings (as shown in Table 2) were greater than 0.5 which is the acceptable minimum cut-off[63]. Results from the Cronbach Alpha test demonstrated consistency among the variables used for the various constructs, with SN having the highest Alpha score (0.8408). This was followed by INT, PBC, and ATT, respectively, with 0.7934, 0.7859, and 0.7182. The Cronbach values were higher and all above the recommended minimum level of 0.7 [55], which is a sign of good reliability.

The average variance extracted (AVE) and Composite Reliability (CR) metrics were used to identify the extent of convergence within constructs in an attempt to explain the variances between items. Findings revealed that AVE's were; 0.48, 0.58, 0.65, and 0.61 for attitude, social norm, perceived behavioral control, and intention, respectively. However, the construct on attitude was less than the suggested threshold of 0.5 and still considered in the modeling. A Justification for further suitability of the construct was referred to the CR value (0.786) of the construct (Table 2), which is greater than the cut-off value of 0.6 [64]. asserted that when the AVE of a given construct is less than 0.5 and the CR value is > 0.6, the researcher can confirm the adequacy of convergent validity. On the other hand, the CR values for all the constructs (ATT, SN, PBC, and INT) was greater than the recommended value of 0.7 [65], with the highest 0.786, 0.843, 0.75, and 0.825 for ATT, SN, PBC, and INT, respectively (Table 2).

The study further considered the Fornell–Larcker Criterion analysis to confirm for discriminant validity (Table 3). Results in bold figures revealed that the average variance extracted (AVE) is greater than it inters construct correlations, and significant which therefore confirmed the discriminant validity.

4.3.1. The measurement model for improved IC breeds

Table 4 depict the results on path analysis of the structural model for improved IC breeds. Results on Chi-square- χ^2 (199.49; $p = 0.000$) depicted a mismatch between the observed covariance matrix and, the estimated covariance matrix, hence rejection of the null hypothesis.

The baseline comparison followed up on two indices namely; Comparative Fit Index (CFI) = 0.94 and Tucker Lewis Index (TLI) = 0.93. Similarly, a population error using Root Mean Squared Error of Approximation (RMSEA = 0.07) was considered during the analysis. In addition to the specification of the population error, the study employed a PCLOSE command that revealed a probability RMSEA of 0.01 which is less than the probability RMSEA <0.07. As well, the size of the residual using Standardized Root Mean Squared Residue (SRMR) = 0.05 (Table 4). Results on all the indices confirmed the fulfillment of the various prerequisites of the structural equation modeling as suggested by Ref. [66] on minimum cut-off value.

Findings from the structural model showed that attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC) significantly explain farmers' intention to adopt improved IC breeds. This implied that the null hypothesis (psychological factors have no effect on farmers' intention to adopt improved IC breeds) was rejected. Studies have validated the effectiveness of the TPB framework and concurrence reached the hypothesis that the three main constructs (attitude, subjective norm, and perceived behavioral control) determine intentions to adopt agricultural interventions[48,67]. Coefficients for the three constructs (ATT, SN, and PBC) were positively significant, a suggestion that the alternative hypothesis for each construct adopted for the study was not rejected. Findings based on the relative sizes of the coefficients revealed that subjective norm was the main driver of intention, followed by attitude, and perceived behavioral control.

Subjective norm (SN) about improved IC breeds was a greater predictor of intention, as demonstrated in Table 5 (standardized path coefficient = 0.434, P < 0.001). The finding on the positive relationship between SN and intention supports hypothesis 2 of the study. The results indicated a substantial relationship between social pressure from other farmers and opinions about behavioral intention

Table 3
Fornell-Larcker criterion on Pearson's Correlation Coefficients for Improved IC Breeds.

Construct	Attitude	Social norm	Perceived behavioral control	Intention
Attitude	**0.70**			
Social Norm	0.419**	**0.76**		
Perceived behavioral control	0.348**	0.372**	**0.81**	
Intention	0.379**	0.557**	0.335**	**0.78**

Source: *Model Output, 2022*

Table 4
Overall Goodness-Of-Fit (GOF) statistics for Improved IC Breeds.

Fit Statistics	Value
Chi-Square (χ^2)	199.49 ($p = 0.000$)
Root Mean Squared Error of Approximation (RMSEA)	0.07
90 % Confidence Interval for RMSEA	0.061–0.086
Pclose	0.001
Comparative Fit Index (CFI)	0.94
Tucker Lewis Index (TLI)	0.93
Standardized Root Mean Squared Residue (SRMR)	0.05
Coefficient of Determination (CD)	0.93

Source: *Model Output, 2022*

Table 5
Structural modelling estimation for improved IC breeds.

Hypothesis	Constructs	Model 1-Unstandardized path Coefficient			Model 2- Standardized Path Coefficient			
SNo.	**R/ship**	**Coef.**	**S. E**	**Z**	**Coef.**	**S. E**	**Z**	**Decision**
Hypothesis $_1$	ATT- > INT	0.152	0.04	3.06**	0.204	0.06	**3.13****	Supported
Hypothesis $_2$	SN- > INT	0.376	0.06	6.26***	0.434	0.06	**7.16*****	Supported
Hypothesis $_3$	PBC- > INT	0.07	0.02	2.52**	0.153	0.06	**2.57****	Supported

Source: *Model Output, 2022*

from family members, relatives, friends, and extension workers. The possible suggestion is that social referencing plays a crucial role of motivating farmers to adopt the newly developed technologies by agricultural practitioners in an attempt to safeguard the embedded social benefits. The capacity to influence farmers' behavioral intentions can be increased by formal or informal perspectives obtained from local networks. As well, farmer's experience with a new technology in terms of performance in a previous year/s promotes availability of information, knowledge and skills, hence increased likelihood of adoption. In the context of this study, peer influence fosters a favorable perspective on smallholder farmers' intentions to adopt IC breeds. Therefore, there is a great need to embrace prior experience from peers, thereby enhancing skills, information accessibility, and further technological adoption [68]. and Borges et al. (2016) attested to the role of social pressure that emanates from family members, friends, and extension officers as a major motivational driver toward behavioral intention among smallholder farmers. Significant causal effect between the social considerations and behavioral intention to adopt is in line with the research of [24,50,67,69].

The positive and significant effect of attitude (standardized path coefficient-β = 0.204, P < 0.05) on intention implies that smallholder farmers who view the outcomes of adopting improved chicken breeds as favorable are more likely to have a positive intention to adopt the technology (Table 5). The finding on the positive relationship between attitude and intention supports hypothesis 1 of the study. In the context of this study, the referenced positive outcomes include; faster maturity rate, increased meat and egg production, and improved farm income. The plausible explanation of this finding is that positive attitude among smallholder farmers reflected an awareness on the different benefits embedded on adoption of the improved IC breeds. An in-depth understanding of the benefits of a technology influences a positive attitude, thus increasing the likelihood of its adoption. Again, smallholder farmers are rational and prefer trying new agricultural technologies once they gain sufficient understanding regarding them. It is therefore important for the poultry stakeholders to put more emphasis on these outcomes of adopting improved chicken breeds. This finding is in concurrence with the previous studies that documented attitude as a significant and positive driver of farmer's intention to adopt agricultural technologies[22,48,69,70]; Hossain et al., 2015; [27].

Results also indicated a positive and significant effect of perceived behavioral control construct on intention to adopt improved IC breeds (standardized path coefficient – β = 0.153, P < 0.05). The finding on the positive relationship between PBC and intention supports hypothesis 3 of the study (Table 5). The probable explanation is that if farmers had a positive perception of being capable (in terms of knowledge, and skills) to control their own resources, or had all the necessary resources required, they would ultimately have the intention to adopt the improved IC breeds. Furthermore, farmer's favorable confidence to assess the conditions of an agricultural technology enhances his/her perceived ability and risks, thus strengthening their PBC which ultimately shapes the adoption behavior. Studies have affirmed that; knowledge, personal abilities, possession of resources and incentives, and the existing institutions and infrastructures are the key determinants of perception towards the practicability of an agricultural intervention[71,72]. Accordingly, stakeholders play a great role in the utilization of the high perception among farmers while providing farmers with the appropriate agricultural interventions[73,74]. Finding on the positive and significant effect of PBC on behavioral intention to adopt is consistent to those of [48,72]; Borges & Lansik, (2016), [38].

5. Conclusion, policy implication and limitations

Integration of Improved IC breeds in poultry production systems serves as a strategic avenue towards addressing low IC productivity. Their inclusion has been considered as the best alternative for survival in a sustainable chicken enterprise among smallholder farmers in developing countries. This study aimed at assessing the socio-psychological determinants of farmers intention to adopt improved breeds among smallholder IC farmers in Kenya using the theory of planned behavior. The study therefore accounts for the intrinsic factors that form a precedent towards adoption of agricultural technologies. Using the TPB framework, the research found the significant role of the considered psychological drivers which included; attitude, subjective norms and perceived behavioral control on farmers' intention to adopt improved IC breeds. Findings support the key role of subjective norms having a strong effect on farmers' intention to adopt improved IC breeds. As per the results, family members, friend's, other IC farmers and government extension officers' accounts as key agents of information dissemination. More attention should focus strengthening different pathways and tools of relaying information on improved breeds among smallholder farmers. For example, use of mobile apps and media channels would increase access and use of information to boost status of adoption of IC breeds.

Secondly, key agricultural stakeholders should support the critical role of cooperatives through formation, promotion and reinforcement of social groups which are central points of circling information among farmers. Furthermore, the study documents attitude as a significant driver of intention towards adoption of improved breeds. Various behavioral beliefs that emerged as drivers of attitude included: faster maturity, increased meat and egg production, and farm income. Finally, the main drivers for perceived behavioral control encompassed: adequate knowledge and skills, sufficient technical skills, and availability of the required resources. The finding implied that resource-based factors had minimal contribution towards adoption of improved indigenous chicken breeds. The results from this study provide useful insights and calls for formulation, development and adjustment of policies that triggers farmers to adopt improved IC breeds. The study calls for an interdisciplinary approach among the different stakeholders such as; communication specialists, programmers, social scientists, extension officers just to mention a few to motivate adoption of improved IC breeds given the complex socio-psychological nature of human behavior.

The study however had some limitations that can be considered for improvement in future researches. Firstly, the study focused more on intention to adopt instead of the actual behavior among farmers in the study area. The approach of understanding farmers intention to adopt improved IC breeds during the interviews was futuristic rather than the actual adoption. It is therefore paramount to consider conducting a follow-up research with the same group of farmers and evaluate the magnitude of intention at predicting the actual adoption behavior. Secondly, the study focused on farmers intention to adopt improved IC breeds in Machakos County, thus the findings aren't generalizable to all poultry farmer in the country. Lastly, the use of PLS-SEM econometric framework does not assume the distribution of data (robust to non-normal data). The model considers relatively small sample size and as a result maximizes the explained variance, and further minimizes the general error term. The attributes of the PLS-SEM model therefore restrict the estimation of the full model while capturing reflective and formative parameters. This calls for a future test of the full model through incorporation of all control, normative, normative and behavioral indicators which can be achieved by increasing the sample size.

Data availability

Data will be made available on request.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Christopher N. Kamau: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Eucabeth B. Majiwa:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Geoffrey O. Otieno:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Lucy W. Kabuage:** Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e22381.

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