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This thesis is dedicated to my wife Pascaline, to my daughter Louise, to my mother Marie A. Tokpohozin and the memory of my late father Jacob Dossa Sodjinou
Abstract

Benin is among the poorest countries in the world with an agriculture-based economy. Poverty is more prevalent in rural areas where, for many people, village poultry plays a significant income generating role. The important position of village poultry in the national meat supply (second most popular source of meat after beef) and in the household’s income suggests that poultry can be a useful tool to alleviate abject rural poverty. It can also be an appropriate means of promoting gender equality and empowerment, since women tend to have more (than other activities) control over poultry production and marketing without needing to seek their husband’s permission. In recognition of this role, the government and various development agencies have supported the development of village poultry in Benin. For this purpose, projects implemented can be separated into two parts: a technical component (CBM: community-based management) and a financial component (microfinance). The overall goal of this study is to assess the impact of these poultry-based interventions on village poultry performance (profitability, poultry survival rate efficiency) and on the rural households’ living conditions (poverty, vulnerability, gender empowerment, education). Methodologically, the work relied on the Sustainable Livelihood Approach as a general analytical framework to analyze how poultry-based interventions contribute to the livelihood of rural households. Depending on the specific objectives, various econometrics tools were used, e.g. censored regression for analyzing factors influencing village poultry survival rate and multiple treatments propensity score matching for impact assessment.

Our main findings show that CBM alone or in combination with microfinance significantly improved recipient households’ income and entrepreneurship regarding village poultry. CBM positively and significantly improved the wellbeing of the participant households. This improvement is more significant when the participants in CBM receive poultry-based microfinance, i.e. microfinance formally granted for village poultry production. In contrast, the use of microfinance without CBM did not significantly improve the wellbeing of the recipient households. CBM only reduced poverty among the poorest households, but without the addition of poultry-based microfinance, participant households did not significantly escape from poverty. Moreover, women in the recipient households have gained more control over resources, i.e. there is an increase in women’s participation in decision-making within households. In short, our results confirm the fact that village poultry is a useful tool for poverty reduction especially among the poorest. However, supporting village poultry will help recipients move out of poverty only if the technical support (that relies on the community) is combined with poultry-based microfinance. The latter is needed for the adoption of village poultry improvement technologies (vaccination of poultry, henhouse construction, and improved feeding).

Key words: Village poultry, Sustainable Livelihood, Poverty and vulnerability, Gender empowerment, Education, Multiple Treatments effect, Propensity score matching, Technology adoption, Productivity, Poultry survival rate, Technical Efficiency, Structure-Conduct-Performance, Market performance, Hedonic price, Benin.
Acknowledgments

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Epiphane SODJINOU
February 2011, Copenhagen
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List of acronyms

ACIAR: Australian Centre for International Agricultural Research
ADB: African Development Bank
AgeFIB: Agence de Financement des Initiatives à la Base (NGO)
ANOVA: Analysis of Variance
ATET: Average Treatment Effect on Treated
ATEU: Average Treatment on the Untreated
AVPAT: Association Villageoise pour la Promotion de l’Aviculture Villageoise
BMZ: German Federal Ministry for Economic Development Cooperation
CBM: Community-Based Management
CBM-AnGR: Community-Based Management of Indigenous Farm Animal Genetic Resources
CeCPA: Centre Communal pour la Promotion Agricole
CLCAM: Caisses Locales de Crédit Agricole Mutuel
CNCA: Caisse Nationale de Crédit Agricole,
CRCAM: Caisses Régionales de Crédit Agricole Mutuel
DANIDA: Danish International Development Agency
DE: Direction de l’Elevage (Livestock Division)
DEA: Data Envelopment Analysis
DFID: Department for International Development (UK)
FAO: Food and Agriculture Organization of the United Nations
FCFA: Franc de la Communauté Financière Africaine (currency)
FECECAM: Fédération des Caisses Locales de Crédits Agricoles Mutuel
FGT: Foster-Greer-Thorbecke
FNM: National Fund of the Microfinance
GDP: Gross Domestic Product
GNI: Gross national income
GNI: Gross National Income
GPS: Global Positioning System
HH: Household
HPAI: Highly Pathogenic Avian Influenza
IMF: International Monetary Fund
INRAB: Institut National des Recherches Agricoles du Benin”
INSAE: Institut National de la Statistique et de l’Analyse Economique
IO: Industrial Organization
KM: Kernel Matching
LATE: Local Average Treatment Effect
MAEP: Ministère de l’Agriculture, de l’Elevage et de la Pêche
MCPP: Programme de Microcrédit aux Plus Pauvres
MDG: Millennium Development Goals
MFI: Microfinance Institution
Nd: Not determined
ND: Newcastle Disease
NGO: Non Governmental Organization
NNM: Nearest-Neighbor Matching
NPBM: Non-Poultry-Based Microfinance
ONASA: Office National pour la Sécurité Alimentaire
PADAV: Programme d’Appui au Développement de l’Aviculture Villageoise
PADFA: Programme d’Appui au Développement des Filières Agricoles
PADME: Programme d’Appui au Développement des Micro-Entreprises
PADME: Programme d’Appui au Développement des Micro-Entreprises
PADSA: Programme d’Appui au Développement du Secteur Agricole
PAMR: Projet d'Appui au Monde Rural dans le Mono
PAMRAD: Projet d'Appui au Monde Rural dans les Départements de l'Atacora/Donga
PAPA: Programme Analyse de la Politique Agricole (Agricultural Policy Analysis Unit)
PAPME: Programme d’appui aux Petites et Moyennes Entreprises
PARMEC: Projet d’Appui à la Réglementation sur les Mutuelles d’Epargne et de Crédit
PBM: Poultry-Based Microfinance
PPAT: Projet Promotion de l'Aviculture Traditionnelle
PRSP: Poverty Reduction Strategy Paper
PSM: Propensity Score Matching
PSRSA: Plan Stratégique de Relance du Secteur Agricole
SAP: Structural Adjustment Programs
SCP: Structure-Conduct-Performance
SCRP: Stratégies de Croissance et de Réduction de la Pauvreté
SFA: Stochastic Frontier Analysis
SLA: Sustainable Livelihood approach
SODERA: Société de Développement des Ressources Animales
SUTVA: Stable-Unit-Treatment-Value Assumption
TE: Technical Efficiency
UEMOA: Union Economique et Monétaire Ouest Africaine
UNAP: Union Nationale des Aviculteurs Professionnels du Bénin
UNDP: United Nations Development Programme
VPV: Village Poultry Vaccinators (in French: VVV: Vaccinateur Villageois de Volaille)
Chapter 1.
General introduction

1.1. Background

1.1.1. Agriculture and poverty alleviation

Poverty is widespread in developing countries and more prevalent in rural areas. Indeed, most of the poor in developing countries (75%) live in rural areas, with agriculture being the centre of their lives (Meyer, 2009: 7). The important position of agriculture in poorer economies suggests that strong growth in agriculture is critical for poverty reduction and for fostering overall economic growth (World Bank, 2007: 28).

Indeed, several country studies reported in the literature showed that no sustainable reduction in poverty is possible without improving the agriculture sector. For instance, in India, Ravallion and Datt (1996) showed that growth in agriculture (following the diffusion of high yield crop varieties) benefits the poor in both urban and rural areas, while growth in manufacturing has no impact on poverty. They also found that rural economic growth reduces poverty in both rural and urban areas, whereas urban growth had no impact on rural poverty. For China, Ravallion and Chen (2007) noted that growth in the agricultural sector was far more important to national poverty reduction than the secondary or tertiary sectors. More recently, in Ghana, rural households accounted for a large share of a steep decline in poverty induced in part by agricultural growth (World Bank, 2007: 6).

In short, in developing countries where the agricultural sector dominates the economy, growth needs to be agriculture led (Estudillo and Otsuka, 2010; Thirtle et al., 2003). For this purpose, it is critically important to develop improved agricultural technologies and to introduce them to poor areas where agriculture is the dominant source of income for rural households (Estudillo and Otsuka, 2010). Improved agricultural technology diffusion is seemingly the most effective means of improving agricultural productivity and reducing poverty and increasing food insecurity (Minten and Barrett, 2008).

In contrast, some economists claim that just because the agricultural sector is large does not necessarily mean that it is a leading sector for economic growth. Thus, Ellis and Harris (2004) assert that policies which facilitate rural-to-urban migration could be more suitable than policies which support agriculture. Dercon (2009) argues that better prospects for reducing rural poverty and stimulating growth might come from non-agricultural sectors, creating additional opportunities for people to exit farming. According to Dercon (2009), because the agricultural sector in most developing countries has very low productivity relative to the rest of the economy, a strategy of exporting non-agricultural goods or cash crops and importing food might prove better than a development strategy based on agriculture. To the extent that policies target rural
areas, Dercon suggests the focus should be on investments in health and education which will make it easier and cheaper for individuals to leave agriculture in due course. In the long run, those who succeed in leaving behind small-hold agriculture are likely to be the best off. Dercon’s point of view is rejected by several economists for whom it is hard to imagine that significant growth or poverty reduction will arrive in the absence of agricultural productivity growth, given that most developing countries have at least one quarter of their workforce employed in agriculture and given the importance of agricultural output in the consumption baskets of the poor (Gollin, 2010).

Concerning Benin, like most developing countries, poverty is more prevalent in rural areas. Data from the National Institute for Statistics (INSAE, 2009) show that in 2007, the incidence of the monetary poverty was 36.1% in rural areas compared to 28.3% in urban areas. The incidence of non-monetary poverty in rural areas (46.9%) is almost two times the value observed in urban areas (27%). The proportion of people suffering from food insecurity in rural areas is about 15.3% compared to 7.9% in urban areas (AGVSAN, 2009: 4).

In this respect, various strategies have been undertaken since the late 1980s to combat rural poverty in particular. However, most of the strategies that have targeted the macroeconomic level during the 1990s have failed. This was the case for the Structural Adjustment Program (SAP) which was implemented between 1989 and 1999, the objective of which was the restoration and consolidation of the macroeconomic stability of the country, and the promotion of economic growth. Indeed, the positive macroeconomic results of the SAP (e.g. economic growth rose from -2% in 1989 to an average annual rate of 4.5% over the period 1990-1999) did not lead to a better distribution of the fruits of growth and the program had negative social impacts (ADB, 2003).

Due to the failure of these macroeconomic strategies in combating poverty, the Government of Benin started a new poverty reduction strategy in 1999 based on Poverty Reduction Strategy Papers (PRSPs), which clearly stress the importance of agriculture in the development of the country and poverty reduction, particularly in rural area. Thus, through PRSPs, the government believes that increasing farmers’ incomes can substantially reduce poverty in rural, as well as urban areas. At the micro level the Government’s strategies rely on various programs, e.g. Strategic Plan for Agricultural Sector improvement (PSRSA),¹ which clearly targets family farming improvement, Agricultural Products Chain Development (PADFA)² which aims to improve the productivity of products such as maize, cassava and poultry, and the Agricultural Sector Development Support Program (PADSA)³ which aims to improve rural populations’ living conditions and reinforce the contribution of the agricultural sector to economic growth.

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¹ In French: PSRSA: “Plan Stratégique de Relance du Secteur Agricole”
² In French PADFA: “Programme d’Appui au Développement des Filières Agricoles”
³ PADSA (in French: “Programme d’Appui au Développement du Secteur Agricole”) has been financed by the Danish International Development Agency (DANIDA) since the late 1990s.
Maize, cassava, cashew nuts, shea tree, and village poultry were the main products targeted by PADSA.

The implementation of all these projects and programs resulted in an improvement in agricultural production in Benin. For example, the amount of cereals produced in Benin is 8% greater than the minimum need of the country, calculated by the National Office for Food Security (ONASA, 2008)\(^4\). Also, the amount of roots and tubers produced in Benin is 38% greater than the minimum need of the country (ONASA, 2008). A more important concern, however, since the change of (Benin) government objectives toward poverty reduction, is the need to assess the impact of various programs and projects (including the adoption of agricultural innovations) on poverty indicators such as income/expenditure, schooling, and health at the farmer’s level (Adegbola, 2010: 4).

### 1.1.2. Village poultry as a tool for poverty reduction

Village poultry\(^5\) can be a useful tool for poverty alleviation and food security mainly in poor countries like Benin for various reasons.

First, village poultry not only has a high share of the meat supply in developing countries, but is also a widespread traditional activity in most of these countries. Indeed, more than 80% of the poultry population of the world is found in traditional family-based poultry production systems, contributing up to 90% of poultry products in some countries (Alabi et al., 2006). Mack et al. (2005) showed that nearly all families living in rural areas of developing countries, including the poor and landless, are owners of poultry. Gueye (2005) supports this when stating that more than 90% of rural families in most developing countries keep one or more poultry species (i.e. chickens, ducks, guinea fowl, geese, and pigeons). In Benin, village poultry is owned by 84% of farm households (Kherallah et al., 2001) and represents the second most common source of meat after beef, with 17% of the meat supply compared to 58% for beef, 9% for goat, 7% for pig, 3% for sheep, 1% for modern poultry, and 5% for bush meats (DE/MAEP, 2008: 40).

Second, village poultry production plays a significant role in income generation and poverty alleviation in a condition where many people are landless or have no formal skills to participate in income earning activities (Fattah, 1999; Aklilu et al., 2008). According to Alders and Pym (2009), impact studies have demonstrated that income from the sale of poultry eggs in South Asia is used to educate children and begin the process of asset accumulation. In Jos South Local Government in Nigeria, Fasina et al. (2007) show that poultry alone contributes over 83% of the cash income of sampled families, proving that poultry is a major economic activity for these families. The sale of poultry products also allows for investment in other livestock such as goats and cattle production, and in other business enterprises (Clarke, 2004).

\(^4\) In French, ONASA: “Office National pour la Sécurité Alimentaire”

\(^5\) Village poultry is also termed family poultry, free-range poultry, rural poultry, traditional poultry, smallholder poultry or backyard poultry. From now on, we will use these terms interchangeably in this work.
Third, village poultry is a useful tool to help poor rural households to recover from disasters, and it provides a practical and effective first step in alleviating abject rural poverty. Indeed, several studies (Dossa et al., 2003; Aklilu et al., 2008) claim that if the poor can acquire poultry it can help them to move out of poverty. A study in the Southern province of Zambia hit by drought and cattle disease, found that households with chickens were able to survive drought and recover the following year better than households without chickens (Clarke, 2004). In Benin, village poultry enables farmers to achieve the annual cycle of family economy by selling poultry during periods of slender means, when the garnerous are empty, in order to afford cereal for family consumption (Gbaguidi, 2001).

Furthermore, village poultry is a cheap source of protein and generally covers part of the rural family's nutritional needs by providing scarce animal protein, in the form of meat and eggs (Copland and Alders, 2005; Mack et al., 2005). Poultry eggs, in particular, offer an important source of nutrition containing about 315 kilojoules of digestible energy and are one of the best sources of quality protein known (Alders and Pym, 2009).

Village poultry, especially chicken and guinea fowl, have a short production cycle and do not require much investment when compared to larger livestock (Copland and Alders, 2005; Kryger et al., 2010). Thus, traditional poultry production is feasible in rural areas where only low cost technology is needed to considerably improve production (Mack et al., 2005). As they are usually left to scavenge for their feed during daytime, poultry only require a little supplementary feeding (depending on the season of the year), a night shelter and, occasionally, some veterinary treatment and vaccination (Kryger et al., 2010). Moreover, most of the conditions required by the industrial poultry sub-sector are not met in rural areas (Branckaret and Gueye, 2000). These conditions include the ability to purchase the most efficient inputs (improved bird breeds, feeds, vaccines, drugs and equipment), the availability of highly skilled manpower and strict disease control (Clarke, 2004; Alabi et al., 2006).

Poultry has also a socio-cultural importance in developing countries. Following Clarke (2004), in many countries, social goodwill is created by offering guests a meal containing meat, which is usually poultry.

Family poultry is also an appropriate means of promoting gender equality in developing countries. Indeed, poultry is almost a universal exception; around the world, women tend to have more control over the poultry they produce and market, and they can also sell or exchange their poultry without seeking their husband’s permission (World Bank/FAO/IFAD, 2009: 602). In the south of Mozambique, women have been able to sell excess chickens in order to buy goats and eventually cattle, thus giving them access to resources previously denied to them, as ruminants have been traditionally raised by men (Alders and Pym, 2009). In a study carried out in the Niger Delta (Nigeria), Alabi et al. (2006) showed that family poultry husbandry (35%) contributes more to the household income of women than business activities (30%) and paid employment.
(18%). In Ethiopia, Aklilu et al. (2008) reported that farmers described poultry as a source of self-reliance for women. Poultry and egg sales are decided by women (Aklilu et al., 2007) and therefore provide them with an immediate income to meet household expenses (e.g. food items) instead of expecting men to provide the cash (Aklilu et al., 2008).

Finally, various studies (e.g. Nielsen et al., 2003a; Clarke, 2004) have shown that poultry-based interventions can contribute to poverty alleviation and food security in rural areas. For example, smallholder poultry projects implemented in Bangladesh since 1993 have improved beneficiaries’ household conditions in many ways (Clarke, 2004). About 28% of the households moved above the poverty line within 18 months, there was an 86% to 99% increase in school enrolment (especially for girls), women gained a greater influence on family decision-making and the household intake of animal protein increased (Clarke, 2004). Also, in a study carried out in Bangladesh, Nielsen et al. (2003a) compared the food intake and consumption patterns of women who were participating in a project aimed at improving village poultry production through improved husbandry practices and disease control to those of non-participating women. Nielsen et al. (2003a) found that the consumption of chickens and eggs was negligible in both groups. But, the group adopting the improved practices had a significantly higher intake of fish. Nielsen et al. (2003a) argue that this effect was related to higher income from improved poultry production, as households that adopted the husbandry and poultry health practices sold more eggs and chickens than households that did not adopt the practices.

However, the productivity of village poultry is low in addition to poor breeding levels. In Benin, the productivity is 50 eggs per year for local hens with an average of 0.04 kg compared to 220 for improved hens with an average of 0.06 kg in weight (DE/MAEP, 2008). But, despite its low productivity, village poultry plays an important role in income generation and poverty reduction in developing countries. For this reason, Mack et al. (2005) argue that village poultry should be considered in any strategy aimed at improving rural livelihoods. Recognizing this role, various development agencies, such as the Australian Centre for International Agricultural Research (ACIAR) and DANIDA, have supported village poultry research in many countries in Asia and Africa.

In Benin, the government has prioritized the development of poultry in its agricultural diversification program since the early 2000s. Thus, various national and international institutions have been or are now aiming at helping the family poultry industry in order to alleviate poverty. The most important implemented programs are the Village Poultry Development Program (PADAV),\(^\text{6}\) funded by DANIDA through PADSA, the Traditional Poultry Promotion Project (PPAT),\(^\text{7}\) funded by Belgium from 1999 to 2003, and a project entitled, “Improving the Livelihoods of Poor Livestock-keepers in Africa through Community-Based

\(^\text{6}\) In French PADAV : “Programme d’Appui au Développement de l’Aviculture Villageoise”. The PADAV project has been designed and implemented with assistance from the Poultry Network based in Denmark.

\(^\text{7}\) In French PPAT : “Projet Promotion de l’Aviculture Traditionnelle”. It was funded by Belgium through the Rural Areas Support Project in Mono province (PAMR: “Projet d’Appui au Monde Rural dans le Mono”).
Management of Indigenous Farm Animal Genetic Resources” (CBM-AnGR), funded by the German Federal Ministry for Economic Development Cooperation (BMZ).

1.2. Problem statement

Several of the institutions that support village poultry as an important means for poverty alleviation have developed various approaches since late 1990s. Most of these approaches are based on the Bangladesh poultry development models, which are typically split into two parts: the technical component and the financial component. As implemented in Benin, the model can be described as follows.

The implementation of the technical part relied on the installment of a ‘poultry interest group’ in each experimental village. This group received various names depending upon the project, e.g. village association for traditional poultry farming promotion8 (in the case of PADAV) and Community-Based Management group (in the case of CBM-AnGR). The members of these groups used to have weekly meetings during which they received training in the basic techniques of poultry management, including village poultry housing, feeding using compound available in the village, and disease control. The members also shared their knowledge, problems and solutions during the meetings. In short, the technical part is based mainly on the community9 and is termed Community-Based management (CBM) in our study.

In order to facilitate the use of introduced technologies in each village, CBM groups were asked to nominate two members (normally a woman and a man), to be sent on a course to become a Village Poultry Vaccinator (VPV)10. These members are selected on the basis of their education level, motivation, reputation and acceptability within the community. Afterwards, they received five-day’s training not only in the techniques of poultry vaccination and treatment against major diseases such as Newcastle disease, but also in technical aspects of village poultry management. Their role is to help farmers in the treatment of diseases and to advise them, notably on good farming practices, especially when the project ends. The introduction of VPVs is justified by the fact that private and government veterinarians are located far from villages and are not interested in traditional poultry.11

By targeting community-based management (CBM), development institutions aim to help villagers to think together and share experiences in poultry production. By doing so, projects/programs are expected to encourage changes, not only in individual farmer’s behavior regarding village poultry farming (henhouse building, vaccination against major diseases,

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8 In French AVPAT: Association Villageoise pour la Promotion de l’Aviculture Villageoise
9 Community corresponds to village dwellers whatever their ethnic groups, religions or origins.
10 In French: "Vaccinateur Villageois de Volaille (VVV)"
11 It is important to note that in some cases (but not those analyzed in this work), CBM is reduced to the installment of VPV only, without providing training to breeders. In this case, the approach is termed Community-based poultry health management. This applies, for example, to PADFA (Project d’Appui au Développement des Filières Agricoles), and PAMRAD (Projet d'Appui au Monde Rural dans les Départements de l'Atacora/Donga (North-west of Benin)) a project financed by Belgium cooperation.
adoption of improved cockerel, use of improved feed and follow-up of birds), but also at the
community level (marketing products together, joint purchasing of inputs such as vaccines and
other veterinary products). The result of this is an improvement in the farm households’ living
conditions.

For the financial part (termed Poultry-Based Microfinance (PBM) in this work), in each
experimental village, CBM members (i.e. participants in CBM) are split into smaller ‘solidarity
units’ of five members who have a common wish to access financial services. These small
groups are similar to the groups used in the Grameen’s approach. Thus, while loans (ranging
from FCFA 10,000 to FCFA 40,000) are made to individuals within groups, all members are
expected to support the others when difficulties arise. This system has been formed in the hope
that repayment will be secured via mutual responsibility and ‘social pressure’ (Thomsen, 2005).
The repayment often starts six months after the initial loan has been granted and continues on
a monthly basis. When a loan which has been borrowed by the members of a given group has been
repayed, the borrowers in the group are offered a larger loan repayable in the next “loan cycle”.
Loans are granted for poultry production (henhouse building, vaccination and poultry feeding),
however, this requirement is not enforced, and micro credits are often at least partly invested in
other activities (Houndonougbo 2005; Thomsen, 2005). Some breeders refused to take this type
of credit, but continue their participation in the technical component of the projects. Among
them, some obtained credit from other microfinance institutions (we term this Non-Poultry-
Based Microfinance (NPBM) in this study), whilst others did not borrow at all.

Overall, the objective pursued through these poultry-based intervention projects or programs is
to move village poultry farming from the rudimentary level to the stage where it can play an
important part in the rural households’ economy. A further aim is to gradually change peasant
mentality from a subsistence-oriented logic to a market-oriented logic.

However, after more than a decade of implementation, it is legitimate to ask whether these
interventions have really contributed to poverty reduction. In other words, what effects have the
interventions had on the adoption of village poultry improvement technologies? How do these
approaches contribute to the performance of village poultry farming? What is the impact of these
approaches on poverty and the wellbeing of rural households? How does the village poultry
market work for the poor producer and how do changes in market performance affect them?

These are some questions that have not yet been satisfactorily answered in any in-depth study.
However, in Benin, some impact studies were carried out by Nielsen et al. (2003b) and
Houndonougbo (2005). However, these studies were limited to the villages in which the PADAV

12 For details on Grameen’s approach see Armendariz de Aghion and Morduch (2005: 12-13).
13 FCFA: Benin currency. Euro 1 = FCFA 655.96 (date: 10/03/2010)
14 Loan cycles – from initial disbursement to repayment of final installment – typically six months.
15 In the case of PADAV, the technical part was carried out by a Non Governmental Organization (NGO) named APRETECTRA
and the microfinance by another NGO named GRAPAD.
intervention was implemented and did not take into account non-experimental villages. This cannot truly help to demonstrate that the changes observed among the target population can be attributed only to the intervention of PADAV rather than to other factors. In other words, they have failed to establish an adequate counterfactual situation and to identify the true causality of change. Houndonougbgo (2005), in his assessment of the impact of microfinance on village poultry farming, showed that there is no significant difference (at 5% level) between the recipients and non-recipients of credit, according to the technical parameters of production (hatching rate, number of chicks per hen, death rate). Also, Houndonougbgo (2005) did not take farm households’ wellbeing into account in his study.

Kryger et al. (2010), in their extensive review of village poultry farming in developing countries, note that most studies on poultry-based interventions struggle with the methodological problems posed by confounding factors associated with the various support activities that are included in many development projects. Moreover, following Dolberg (2003), despite the fact that micro-credit has been an important component in various poultry-based interventions undertaken in various developing countries, impact studies have not clearly distinguished between the benefits of micro-credit (financial part) and the benefits of poultry production (technical part of the projects). Islam and Jabbar (2005) claim that more objective impact studies are required to understand the effect of poultry-based interventions on recipient households. Such knowledge is essential to guide the intended adaptation or replication underway in several countries or to guide further efforts in using poultry as a tool for poverty alleviation.

The work presented in this thesis aims to fill this gap by relying on a nonparametric method, multiple treatments Propensity Score Matching (PSM), to assess the impact of the technical part (CBM), the impact of the microfinance (poultry-based or not) and the impact of both. The choice of PSM method is justified by the fact that the participation in poultry-based projects analyzed in this study, is not randomly assigned. Indeed, there is self-selection into treatment\textsuperscript{16}, i.e. households (partly) decide for themselves whether they will participate in the project and their decision may be related to the benefits derived from this project. Ignoring this issue in the estimation procedure leads to biased estimates and dubious policy recommendations (Faltermeier and Abdulai, 2009). Therefore, this study assessed whether participation in CBM and/or microfinance programs has a causal impact on the living conditions of rural households by using a non-parametric method, multiple treatments PSM, to control for selection bias that normally occurs when participation in the treatment is non randomly assigned. In the literature on impact assessment, PSM usually refers to the methods that aim to identify for each participant one or more similar individuals (in term of covariates $x$) in the non-participants group\textsuperscript{17}. It is a method of sampling from a large reservoir of potential controls to produce a control group of modest size

\textsuperscript{16} In the impact assessment literature, the program that one intends to evaluate is also called treatment or intervention and the effect is called treatment effect or causal effect. From now on, the words treatment and intervention will be used interchangeably.

\textsuperscript{17} In the impact assessment literature, participant in the program (i.e. the individual or household who participate in the program) is called treated, participant, beneficiary or recipient. The individual or household who do not participate in the program are called control, untreated, non-participant, non-beneficiary or non-recipient.
in which the distribution of covariates is similar to the distribution in the treated group (Rosenbaum and Rubin, 1983).

1.3. Objectives of the thesis

The overall goal of this study is to assess the impact of poultry-based interventions on the performance of village poultry and on rural households’ living conditions. The ultimate aim is to suggest policy options which can better support village poultry farming in order to contribute to rural poverty reduction strategies in Benin. The specific underlying objectives inherent to this general objective are to:

- assess the socioeconomic and institutional factors which influence the adoption of village poultry improvement technologies (vaccination, henhouse, chick-house, improved feed and improved cockerel), including the effect of community-based management and microfinance on the adoption of these technologies;
- evaluate the impact of community-based management and poultry-based microfinance on village poultry performance (profitability, poultry survival rate and technical efficiency);
- estimate the impact of poultry-based interventions on households’ living conditions (poverty, vulnerability, gender empowerment, and investment in education);
- analyze village poultry market performance. This includes the assessment of marketing channels that have an impact not only on the production of village poultry, but also on poverty alleviation, as well as the traders’ preferences for village poultry characteristics.

1.4. General analytical framework

This research uses the Sustainable Livelihood Approach (SLA) to review how poultry-based interventions contribute to the livelihood of rural households. The SLA puts the people – the farmers or smallholders – at the centre of the analysis. The framework (figure 1.1) has been developed to help understand and analyze the livelihoods of the poor, especially in the common situation in which communities and individuals sustain themselves by multiple activities (DFID, 2001; Tao and Wall, 2009). A livelihood encompasses income, both cash and in-kind, as well as the social institutions (kin, family, compound, village and so on), gender relations, and property rights required to support and to sustain a given standard of living (Ellis, 1998). A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base (Krantz, 2001).

DFID (2001) states that the framework does not attempt to provide an exact representation of reality. It does, however, provide a more realistic framework to assess the direct and indirect effects of poultry-based interventions on rural dwellers’ living conditions than, for example, one-dimensional productivity or income criteria.
Our aim in this study is not to investigate each element laid out in the SLA framework, but rather to examine the role of poultry in the livelihoods of rural households, and to assess if and how poultry-based interventions affect poverty. In other words, the aim is to appreciate how rural households have changed (e.g. in terms of village poultry management, gender empowerment, poverty, vulnerability and investment in education) after participating in a poultry-based project.

Before analyzing these changes in the following chapters, there is a need to discuss briefly the terms ‘wellbeing’ and ‘poverty’. Based on the historical studies of meaning and measurement of poverty and wellbeing summarized by Chambers (2006), four clusters of indicators can be identify and categorized:

- those that measure poverty as primarily economic wellbeing, and in which poverty has been related to income or its common proxy consumption-poverty;
- those that measure poverty as primarily non-economic wellbeing (this includes lack or low quality of basic assets such as shelter, clothing, furniture, personal means of transport, radios or television, no or poor access to public services);
- those that express poverty as capability deprivation, referring to what we can or cannot do, can or cannot be (this goes beyond material lack or want, and includes human capabilities, for example skills and physical abilities, and also self-respect in society); and
- those that measure poverty as composites. This cluster takes a yet more broadly multi-dimensional view of deprivation, with material lack or want as only one of several mutually reinforcing dimensions.

![Sustainable livelihoods framework](image)

**Figure 1.1. Sustainable livelihoods framework**

In practice, in this study, two types of approaches have been used to assess poverty. The first is based on farmers' perceptions of their own living conditions. In this case, we used the wealth ranking, with the help of key-informants (cf. details in section 2.1.2.). The second is based on consumption expenditure methods (first cluster of indicators presented above) and the Foster-Greer-Thorbecke (FGT) poverty index (cf. detail in section 5.3.1).

1.5. **Outline of the thesis**

Apart from this introductory chapter, the thesis includes six further chapters. Chapter 2 starts by describing the study area and the data collection process. It then describes Benin’s poverty profile, as well as the poultry and microfinance sectors in Benin.

Chapter 3 analyzes the socioeconomic and institutional factors which influence the adoption of village poultry improvement technologies (village poultry vaccination, henhouse and chick-house building, improved feed, improved cockerels), using logistic regression. The effects of CBM and microfinance on the adoption of these technologies are also assessed in this chapter.

Chapter 4 revolves around the analysis of the contribution of CBM and PBM to village poultry performance. First, this chapter uses the enterprise budget approach to analyze the profitability of village poultry farming, with a comparison between participant and non-participant farmers, and between female and male. Next, the chapter analyzes the factors which influence village poultry survival rate using censored regression. Finally, the chapter applies a stochastic frontier analysis using a translog production function to determine whether there were any significant differences in village poultry performance between participants and non-participants in CBM.

Chapter 5 evaluates the impact of poultry-based intervention (CBM and PBM) on rural households’ living conditions, notably poverty, household’s vulnerability, gender empowerment (control over resources and participation in decision making), and education. The main econometric method used is multiple treatments propensity score matching (PSM).

Chapter 6 focuses on the village poultry marketing analyses. The structure-conduct-performance (SCP) method is the main approach used. In addition, hedonic regression is used to analyze traders’ preferences for village poultry characteristics. Data for this analysis have been collected on rural as well as urban markets in order to assess the potential for improved marketing strategies and opportunities for the household.

Chapter 7 outlines the general conclusions of the thesis. In this chapter, political options are proposed and recommendations are made as to how village poultry farming can be better supported.
Chapter 2.  
Survey data, poverty profile, poultry and microfinance sectors in Benin

The aim of this chapter is to provide the background information for the following chapters. It describes the study area and the methodology used to collect various data used in the study (section 2.1). Section 2.2 describes Benin’s poverty profile and the importance of the agricultural sector for the economy of Benin. In section 2.3, the poultry sector is described, including various strategies for its development in Benin. The microfinance sector in Benin and the Government strategies in this sector are presented in section 2.4.

2.1.  The study area, sampling and data collection

2.1.1.  The study area

This study was carried out in the republic of Benin (figure 2.1), a coastal country in West Africa with a land area of 114,763 km², and bordered by Nigeria (to the East), Togo (to the West), Niger and Burkina-Faso (to the North), and the Atlantic Ocean (to the South). It is subdivided into 12 provinces, which are further subdivided into 77 districts.

It has a hot and humid climate with the south being sub-equatorial and characterized by two rainy seasons (April to July and October to November) and two dry seasons (August to September and December to March). The north has a tropical climate, which is less humid with one rainy season (May to October) and a dry season (November to April).

The population of Benin was 9.2 million in 2010, with 58% living in rural areas (UNDP, 2010: 186). More than half the total population is under 18 years of age. The average life expectancy was about 60.8 years in 2007 (62.9 years for women and 58.6 years for men) (AGVSAN, 2009).

The country is made up of more than 100 ethnic groups. The most dominant ethnic groups are Fon/Goun, located in the South (about 39.2% of the total population), Yoruba in the Southeast and the Centre of the country (about 12.3% of the population), and Bariba in the northern part of the country (9.2% of the population) (INSAE, 2003).

Communities practice foreign religions (mostly Christianity and Islam) and traditional ones (cult Voodoo). The Voodoo cult is the most dominant and its practice is often simultaneous with Christianity or Islam. During the celebration of this traditional religion, poultry with certain characteristics, e.g. the color of the plumage (cf. section 6.6 for further details), are frequently used.

Regarding inflation, the rate has dropped from 5.4% in 2005 to 3.8% in 2006 and was less than 3% on average during the first half of 2007 (IMF, 2008).
Figure 2.1. Republic of Benin: geographical location of surveyed villages

Source: Realized (for this study) by “Institut Géographique Nationale” (IGN) – Benin – October 2010
2.1.2. Sampling

The data used in this study come from a survey of poultry-keeping households and poultry traders, conducted from January 2009 through May 2010. The method used was the multistage sampling technique. The primary sampling units are the research villages and the ultimate sampling units were poultry-keeping households and poultry traders.

- Selection of research villages

In the southern and northern parts of Benin, one province was selected based on three main criteria: the level of rural poverty, the level of food insecurity and the implementation of village poultry-based projects/programs in the past ten years. Donga (in the North) and Mono (in the South) are the two provinces that satisfied these criteria. Indeed, Mono is the province with the highest rate of food insecurity in Benin, with roughly 33% compared to 19% in Donga province and 12% at the national level (AGVSAN, 2009). Donga has the highest number of households living on less than $US 1 a day, about 84%, compared to 62% in Mono and 61.5% at the national level (INSAE, 2009).

In each province, two districts where poultry-based interventions have been implemented during the past decade were selected. These districts reflect key dimensions of variation in poultry management (according to programs/projects, different social, cultural and agro-ecological contexts).

In each district, discussions with resource-persons (development agents, extension agents and researchers) enabled us to identify experimental villages (i.e. villages where CBM was or are implemented): in total 8 to 10 in each district. Among these experimental villages, PADAV had been implemented in 5 villages (in each district), whilst other projects or NGOs (in particular GROSPERE, BØRNEfonden, PAMRAD)\(^\text{18}\) were active in other villages.

Based on these results, two categories of village were considered in each district (cf. figure 2.1): two experimental villages and one non-experimental village. So, in total, eight experimental villages (seven within PADAV and one for BØRNEfonden) and four non-experimental villages were selected for the study (table 2.1).

Table 2.2 shows that, in the same region, experimental and non-experimental villages have similar characteristics with regard to the number of households (on average 259 in the South and 191 in the North), the ethnic groups and the average household size (5.2 members in the South and roughly 7.6 members in the North).

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\(^{18}\) GROSPERE is a national NGO, BØRNEfonden is a private Danish sponsor organization, and PAMRAD (Projet d'Appui au Monde Rural dans les Départements de l'Atacora/Donga) is a project financed by Belgium cooperation.
Table 2.1. Sample villages per region

<table>
<thead>
<tr>
<th>Provinces (Region)</th>
<th>Districts</th>
<th>Experimental villages</th>
<th>Non-experimental villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga (North)</td>
<td>Djougou</td>
<td>Foumbéa, Kpébouco</td>
<td>Yorossonga</td>
</tr>
<tr>
<td></td>
<td>Ouaké</td>
<td>Kpéléoudé, Tchaladé</td>
<td>Sobite</td>
</tr>
<tr>
<td>Mono (South)</td>
<td>Houéyogbé</td>
<td>Doutou, Gogohondji</td>
<td>Gboho</td>
</tr>
<tr>
<td></td>
<td>Bopa</td>
<td>Gbakpodji, Houegbo</td>
<td>Zizagué</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2.2. Some characteristics of experimental and non-experimental villages

<table>
<thead>
<tr>
<th>Regions</th>
<th>Villages</th>
<th>No. of households</th>
<th>Average household size</th>
<th>Main ethnic groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Experimental</td>
<td>255.8</td>
<td>5.5</td>
<td>Fon, Sahoue</td>
</tr>
<tr>
<td></td>
<td>Non-experimental</td>
<td>262.0</td>
<td>4.9</td>
<td>Fon, Sahoue</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>258.9</td>
<td>5.2</td>
<td>Fon, Sahoue</td>
</tr>
<tr>
<td>North</td>
<td>Experimental</td>
<td>192.0</td>
<td>8.3</td>
<td>Lokpa, Dendi, Yao, Bariba</td>
</tr>
<tr>
<td></td>
<td>Non-experimental</td>
<td>190.5</td>
<td>7.0</td>
<td>Lokpa, Dendi, Yao, Bariba</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>191.3</td>
<td>7.6</td>
<td>Lokpa, Dendi, Yao, Bariba</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Experimental</td>
<td>223.9</td>
<td>6.9</td>
<td>NN</td>
</tr>
<tr>
<td></td>
<td>Non-experimental</td>
<td>226.3</td>
<td>5.9</td>
<td>NN</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>224.7</td>
<td>6.5</td>
<td>NN</td>
</tr>
</tbody>
</table>

NN = Not Need

Source: After INSAE (2003).

- **Livestock-keepers’ households**

In each research village, livestock-keepers’ households were selected by using stratified sampling techniques. Thus, the households were first grouped into four classes based on a wealth ranking (cf. appendix 1 for the tools used for wealth ranking). Wealth ranking refers to a participatory method used by people from the community to classify households into four or five levels of poverty based on their own criteria (Ranjani et al., 2008). In this study, the objective of this exercise was to obtain local views on the visible components of wealth and poverty.

The wealth ranking, in each village, started with the listing of all households with the help of key informants. After that, the process continued as follows.

1) Five key informants (3 men and 2 women) were selected in each village and an arrangement was made with them regarding the meeting date, time, duration (max. 2 hours) and venue (except for public places and village chief’s house). Key informants of the village were people who had a perfect knowledge of the households of the village.

2) Each key informant was first asked to nominate how many different wealth status classes of households there were in the community/village. Then, each key informant was asked to list the criteria used to differentiate the wealth status classes. The criteria used by key-informants are summarized in table 2.3.
In the South, the first factor of wealth is the amount of land owned. This is followed by the amount of land cultivated per year, the possession of oil palm plantations, practice of animal breeding and the state of the household’s house. Health and the possession of many children was the final wealth factor. In the North, the first factor of wealth was the possession of many children followed by the state of the house. These were followed by food security (self-sufficiency in food), the practice of animal breeding, the amount of land cultivated and the schooling of children.

The results show that the amount of land owned, which is the first factor of wealth in the South, is ranked ninth in the North. Also, the number of children, which is the first factor of wealth in the North, is only the sixteenth factor in the South. This can be explained by the fact that, in the South, land is relatively rare and is the most limiting factor in agriculture production, whereas in the North, land is available and farmers need manpower to produce. Animal keeping is ranked fourth in both regions.

Table 2.3. Main criteria used by key-informants in their wealth ranking

<table>
<thead>
<tr>
<th>Factors</th>
<th>South</th>
<th></th>
<th>North</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean rank(1)</td>
<td>Rank</td>
<td>Mean rank(1)</td>
<td>Rank</td>
</tr>
<tr>
<td>Amount of land owned</td>
<td>4.44</td>
<td>1</td>
<td>9.97</td>
<td>9</td>
</tr>
<tr>
<td>Amount of land cultivated per year</td>
<td>5.29</td>
<td>2</td>
<td>7.17</td>
<td>5</td>
</tr>
<tr>
<td>Cashew nut (North) or oil palm (South) plantation</td>
<td>5.43</td>
<td>3</td>
<td>10.57</td>
<td>12</td>
</tr>
<tr>
<td>State of the house</td>
<td>6.61</td>
<td>5</td>
<td>4.71</td>
<td>2</td>
</tr>
<tr>
<td>Have house in rent</td>
<td>10.69</td>
<td>14</td>
<td>10.78</td>
<td>13</td>
</tr>
<tr>
<td>Practice of petty trade</td>
<td>8.38</td>
<td>7</td>
<td>10.21</td>
<td>11</td>
</tr>
<tr>
<td>Have transport means</td>
<td>8.22</td>
<td>6</td>
<td>8.08</td>
<td>7</td>
</tr>
<tr>
<td>Level of formal education</td>
<td>10.56</td>
<td>13</td>
<td>10.78</td>
<td>14</td>
</tr>
<tr>
<td>Schooling of children</td>
<td>9.41</td>
<td>9</td>
<td>7.66</td>
<td>6</td>
</tr>
<tr>
<td>Animal keeping</td>
<td>6.60</td>
<td>4</td>
<td>6.41</td>
<td>4</td>
</tr>
<tr>
<td>Food security (self-sufficiency in food)</td>
<td>8.59</td>
<td>8</td>
<td>5.91</td>
<td>3</td>
</tr>
<tr>
<td>Practice of handicrafts</td>
<td>10.47</td>
<td>12</td>
<td>10.78</td>
<td>15</td>
</tr>
<tr>
<td>Food processing</td>
<td>9.73</td>
<td>11</td>
<td>10.78</td>
<td>16</td>
</tr>
<tr>
<td>Good health</td>
<td>10.96</td>
<td>15</td>
<td>8.22</td>
<td>8</td>
</tr>
<tr>
<td>Many children</td>
<td>10.96</td>
<td>16</td>
<td>3.79</td>
<td>1</td>
</tr>
<tr>
<td>Other (to have children in urban area, go to Mecca, etc.)</td>
<td>9.66</td>
<td>10</td>
<td>10.20</td>
<td>10</td>
</tr>
</tbody>
</table>

(1) Mean value of the ranking made by key-informants of the region.

3) For the ranking, each key informant was asked to classify the households into different wealth groups, according to the criteria previously elicited. At the end, all key informants were put together, in order to reach agreement regarding the final wealth group of each household.

4) In the experimental villages, each class of households was separated into the treated and control households. Within each sub-class (in experimental villages) and classes (in non-
experimental villages), households were selected at random by applying a quota based on the following formula:

$$q = \frac{n}{N}$$

(2.1)

with $N$ being the number of households identified in the village, $q$ the sampling coefficient and $n$ the total number of households to be selected in the village. Thus, for each class/subclass with $n_i$ members, the number of households selected was obtained as followed: ($q \times n_i$). In total, 30 households in the experimental villages and 15 households in the non-experimental villages were selected at random without replacement.

The total sample size constitutes 303 households: 150 in the North and 153 in the South (table 2.4). Their distribution per wealth status is as follows: 11% very poor households, 38% poor households, 45% medium households and 6% rich households.

In each household, all members who produced poultry were interviewed as well as all household members who were old enough to obtain a loan (mainly the household’s head and his spouses).

It should be noted that, during the quantitative data collection, when a household refused to participate in the study, or when all household members (notably the husband and his wife) were absent, the household was replaced by another household randomly selected in its class or subclass. But overall, the rate of refusal or failure was low, about 3% (5 / 153) in the south and about 5% (7 / 150) in the North.

### Table 2.4. Sample size: number of households per village status and wealth status

<table>
<thead>
<tr>
<th>Wealth status</th>
<th>Non-experimental village</th>
<th>Experimental village</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-participant in CBM</td>
<td>Non-participant in CBM</td>
<td>Participant in CBM</td>
</tr>
<tr>
<td>Very poor</td>
<td>11</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Poor</td>
<td>23</td>
<td>43</td>
<td>50</td>
</tr>
<tr>
<td>Medium</td>
<td>28</td>
<td>33</td>
<td>75</td>
</tr>
<tr>
<td>Rich</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>92</td>
<td>147</td>
</tr>
</tbody>
</table>

- **Poultry traders**

The market surveys were conducted in five rural and four urban markets. The rural markets selected were those situated in (or close to) the villages selected above for the poultry production study. In the South, the rural markets surveyed were 150 km to 200 km from the Capital Porto-Nov, whereas those surveyed in the North were 700 km to 800 km from Porto-Nov. The urban markets were selected in order to easily follow the movements of poultry products from rural (research sites) to urban/consumption areas.
In each market, a list of poultry traders operating in the market was made with the help of key informants. Afterwards, traders were sampled at random: 10 in each rural market and 20 in each urban market (table 2.5). Thus, a total of 130 village poultry traders were interviewed during marketing transactions of poultry on two market-days in the rural markets and four market-days in the urban markets.

Table 2.5. Sample of poultry traders per region and markets

<table>
<thead>
<tr>
<th>Region</th>
<th>Districts</th>
<th>Market</th>
<th>Type of market</th>
<th>Number of interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Allada</td>
<td>Avakpa</td>
<td>Rural</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bopa</td>
<td>Lobogo</td>
<td>Rural</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Cotonou</td>
<td>Dantokpa</td>
<td>Urban</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Houéyogbé</td>
<td>Doutou</td>
<td>Rural</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Porto-Novo</td>
<td>Ouando</td>
<td>Urban</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>North</td>
<td>Djougou</td>
<td>Kolokonde</td>
<td>Rural</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Djougou</td>
<td>Djougou</td>
<td>Urban</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Ouaké</td>
<td>Kassoua</td>
<td>Rural</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Parakou</td>
<td>Arzéké</td>
<td>Urban</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>130</td>
</tr>
</tbody>
</table>

Other stakeholders

Various other actors were also interviewed during this study. These included Village Poultry Vaccinators (VPVs), members of the extension and veterinary services, workers from project/programs involved in village poultry promotion, and employees from research institutions and Microfinance Institutions (MFIs). Of these actors, all who were presented or who had taken any action in the research villages were interviewed. In total, 12 VPVs, four from the extension services, two members of the private veterinary services, two employees from research institutions and six from MFIs were interviewed.

2.1.3. Data collection

Data used in this work were collected in three phases: (i) pre-study, (ii) qualitative survey, and (iii) in-depth survey and quantitative data collection.

Pre-study: literature review and secondary data collection

The literature review facilitated a deeper understanding of various theoretical frameworks valuable for the achievement of the research aims. During this phase, the existing secondary data was also analyzed as well as the importance of village poultry in Benin. Information was also collected on different projects involved in village poultry farming in Benin and their approaches.
and innovations. The information collected during the literature was used to improve guides for qualitative survey and questionnaires for quantitative data collection.

- **Qualitative survey**

The second phase of this research was related to the qualitative survey. The tasks performed during this phase were:

- Wealth ranking of households (cf. section 2.1).
- Focus group discussions. Two focus group discussions were carried out in each research village (one with women and one with men), with the help of two enumerators from the Agricultural Policy Analysis Unit (PAPA)\(^\text{19}\). Each group comprised 8 to 12 individuals, some of whom were participating in poultry-based project, whilst others were not. The main aspects tackled during these focus group discussions were related to major poultry diseases and their control, the proportion of community members keeping the different livestock species, selection of poultry parents and the characteristics of an ideal breeding stock, village poultry housing and feeding, management practices, poultry-based projects carried out in the village during the past decade, marketing of village poultry and constraints on village poultry development. During the focus group, three main problems affecting village poultry production were selected by the farmers and analyzed using a problem tree. The Problem Tree Analysis (also called situational analysis) helps farmers to identify solutions by mapping out the anatomy of cause and effect around a given problem.

- Semi-structured discussions with resource-persons, namely village poultry vaccinators, actors from NGOs involved in poultry-based projects during the past decade, employees from research institutions, extensions agents of CeCPA (Agricultural Promotion Centre, at District level)\(^\text{20}\) and employees from MFIs available in our research area. The main objective here was to obtain their point of view on village poultry improvement technologies (vaccination, housing, feeding), their opinions regarding how to improve village poultry farming, their perception of poultry-based projects and their suggestions for future interventions.

- Observations. The tasks here were mainly to observe some henhouses, ask the owners some relevant questions and take pictures of some of them. We also observed the products used by the breeders to feed their birds and the equipment used by the VPVs.

- Semi-structured discussions were conducted with poultry traders in order to understand the actual dynamics of the market, and to identify the mechanisms that determine market prices. This also facilitated an understanding of the path that poultry products from our research villages followed before reaching consumption or urban markets.

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\(^{19}\) PAPA: “*Programme Analyse de la Politique Agricole*” of “*Institut National des Recherches Agricoles du Benin*” (INRAB)

\(^{20}\) CeCPA: “*Centre Communal pour la Promotion Agricole*”.
Apart from the guides used for the wealth ranking, three other types of semi-structured interview guides were used during the qualitative survey (cf. appendix 2). The first was used for focus group discussions in research villages, the second for interviews with resource-persons, and the third for poultry traders.

The phase ended with an analysis of the data from qualitative survey and the improvement of questionnaires for quantitative data collection.

- **In-depth survey/quantitative data collection**

Here, the work was mainly focused on the quantitative data collection on village poultry production, poultry-keepers’ households and poultry traders. Three types of questionnaire were used: one for livestock-keepers’ households, one for poultry traders, and one for VPVs (cf. appendix 3).

The questionnaire for livestock-keepers’ households was subdivided into four modules. Data collected through the first module, ‘generalities’, were related to the characteristics of the head of the household (age, sex, education level, literacy, matrimonial status, experience in poultry keeping, organizational status, farm and non-farm activities), the characteristics of their household and house (type of house, the economic situation of the household), asset holding (radio, television, phone, bicycle, car, etc.) and listing of the household members. For the module (as well as for the second module), the household head and/or his wife were interviewed according to the aspects targeted by the module.

The second module, “impact assessment,” covered a broad range of data valuable for an impact assessment on poultry-based interventions. These included consumption, investment in education, investment in health, women’s living conditions (income, control over resources, participation in decision making), peasants’ perceptions, etc.

The third module (used mainly for the interview of the household’s members who keep poultry) was for village poultry farming systems. It helped to gather data on:

- Livestock keeping: type of species/races, poultry farming management, equipment, management of diseases, disease treatment costs, current contribution of poultry to household’s income, and other social functions, etc.

- Innovations/new production technologies: knowledge of different innovations, appreciation/perception of the innovations, adopted innovations and the reasons for adoption, non-adopted innovations and related reasons.

- Inputs and outputs of poultry farming: fixed costs (tools and equipment, their prices), variable costs (inputs, availability and costs), labor, quantity of poultry products marketed, etc.

- Marketing: places, condition of animal transport, age of animals marketed, who decides on the place and moment to sell animals, taxes, market prices, marketing constraints, etc.
The fourth module (used for the interview with the household members who were old enough to obtain microfinance) was mainly for the gathering of data on microfinance. Data collected within this module were related to access to credit, the demand and obtaining of credit, the repayment of the credit, the credit obtained from traders, information on the last loan obtained, and the problems/constraints that limit access to credit.

At the traders’ level, the questionnaire facilitated the collection of data on poultry traders’ socio-demographic characteristics (age, sex, education, literacy, matrimonial status, membership of traders’ organization, etc.) and their marketing activities (main types of poultry, main markets, conditions of supply, losses, conditions of transport, transaction costs, mechanisms that determine market prices, taxes, selling/buying prices, manpower, equipment, financing, marketing constraints, potential niche markets and constraints to access these markets, etc.).

For the VPV, data gathered included their socio-demographic characteristics (age, sex, education, literacy, matrimonial status, membership of peasants’ organization, etc.), their training in village poultry vaccination, their work (organization, demand and intervention strategies), the financing of their activities and problems/constraints.

It should be noted that temporary distributed data were collected at the market level. These data mainly concerned bimonthly poultry product prices from each of the sample markets. Figure 2.2 summarizes the methodology used in this study.

2.1.4. Assurance of data quality

To ensure data quality, various strategies were used from the preparatory phase until the data analysis. First, during the preparatory phase, draft questionnaires were sent to various resource-persons (researchers, extension workers, development agents) based on their areas of specialty. The aim was not only to obtain their opinions on the guides and questionnaires (length, content, aspects that can be added or deleted), but also to obtain their perception on the concordance between the questions and field realities. This allowed us to make improved versions of various tools, which were then used to train the interviewers.
Figure 2.2. Synthesis of various steps of the study
HH: Household, Q: Questionnaire, SCP: Structure-Conduct-Performance, SFA: Stochastic Frontier Analysis
Second, all enumerators were trained before the field work. Indeed, the administration of the questionnaires was made possible with the help of eight enumerators who had at least a "Baccalaureate" (Benin national secondary-school diploma) with at least five years experience in socio-economic data collection. The enumerators were given a two-day training session during which they were introduced to the purpose of the study and its scope. They were then taken through the questionnaires: each question was read and explained, and the idea behind the question stressed. The training also enabled the translation of some key questions into the local languages and resulted in an appreciation of the complications they present, whilst removing ambiguities where necessary. Indeed, questionnaires were administrated in local languages, which were predominantly Fon/Goun in the South, and Lokpa and Bariba in the North.

Third, all guides and questionnaires were pre-tested before being used. This pre-test took place in one experimental village, which is not among our research villages, just after the training of the enumerators. During this pre-test, each enumerator was asked to interview one household, to record all problems encountered and the time spent. The same work was done in one poultry market in order to test the traders' questionnaire. After the pre-test, a small meeting allowed us to take relevant improvements into account.

Fourth, during the quantitative data collection phase, about 15% (46/303, at household level and 20/130 at traders’ level) were validated. The validation consisted of going into the sampled households and asking the household’s head some questions from the questionnaire (10 questions in total – cf. appendix 4, validation questionnaires). The objective was to ensure that the enumerators had actually conducted the survey with the household and to verify the consistency of the responses with those obtained by the enumerator. The validation was performed by the author. There were two main reasons as to why the responses obtained during the validation did not correspond to those obtained by the enumerator: (i) the farmer had given inconsistent answers (memory problem), in this case we replaced the household by another from the same class (this occurred in only 2 households), (ii) the enumerator had improperly conducted the investigation (e.g., he did not ask the questions correctly, or had problems in translating the questions into the local language). Fortunately, this did not occur, which was mainly due to the education level and experience of the enumerators used.

Fifth, during the quantitative data collection phase, to avoid mistakes, we went through every completed questionnaire in order to ensure that it was not partially completed. The purpose was also to detect and correct errors as soon as possible. When these occurred, the enumerator was asked to go and see the household.

Furthermore, for the quantitative data collection phase, the enumerators were equipped with digital scales for animal weighing (three birds in each household), a digital camera and GPS (Global Positioning System)\(^{21}\) for taking the geographical coordinates of households (these

\(^{21}\) The GPS used was Garmin GPSMAP 60
Survey data, poultry and microfinance sectors in Benin

coordinate were taken at two meters from the main entrance of the household’s main house). The coordinates of the village were taken at the most central junction of the village. The distance between the village and the nearest main town (and rural market) was taken by reading the dashboard of the car that was used. The aim of collecting this information was to estimate the distance between the household and the nearest main town (and rural market).

Finally, it should be noted that the participant and non-participant households received the same type of questionnaire and were treated identically. However, before the interview with a given non-participant household, the first task was to ensure eligibility for the survey, by asking whether at least one member of the household produced poultry. If the household responded negatively, a replacement household was interviewed in the same class.

After the fieldwork, the questionnaires were checked and codified. Data recording was conducted using Microsoft Access software. The analysis tools depended on the research objectives and theoretical framework (details can be found in each chapter).

2.2. Benin’s poverty profile and agriculture in the economy

2.2.1. Benin’s poverty profile

The vast majority of people living in Benin are poor. Indeed, with a Gross National Income (GNI) per capita of $US 1,499 in 2008, Benin belongs to the poorest countries of the world (UNDP, 2010: 145). Its human development index, estimated at 0.435, places the country 134th out of 169 countries (UNDP, 2010: 145). The growth rate of its economy was less than 4% between 2003 and 2006 (for a demographic growth rate of 3%), which is below the 7% needed to reach the Millennium Development Goals (MDG) (AGVSAN, 2009: 10). More than half of the population of Benin, roughly 51.6%, live on less than $US 1 per day (INSAE, 2009). The level of monetary poverty increased from 28.5% in 2002 (SCRP, 2007) to 33.3% in 2007 (INSAE, 2009). Non-monetary poverty decreased from 43% in 2002 (SCRP, 2007) to 39.7% in 2007 (INSAE, 2009). Regarding subjective poverty, 38.7% of households believed that they had difficulty living in 2006. All these figures show that most of the population of Benin is affected by poverty and that it has increased during the past decade.

Like most African countries, poverty is more prevalent in rural Benin. In 2007, the incidence of monetary poverty was 36.1% in rural areas compared to 28.3% in urban areas (INSAE, 2009). The incidence of non-monetary poverty in rural areas (46.9%) is almost twice the value observed in urban areas (27%). Moreover, 61.5% of the rural populations live on less than one dollar a day.

22 In impact assessment, treated and control households must be interviewed at almost the same time with the same questionnaire, in order to avoid bias (see Heckman et al., 1999).
23 The rate of monetary poverty is the proportion of the population living below the income poverty line.
24 Non-monetary poverty is the level of poverty defined on the basis of the material life conditions of the population.
25 Subjective poverty measures the people’s perception of their own life conditions.
compared to 34.3% in urban areas. Also, the proportion of people suffering from food insecurity in rural areas is about 15.3% compared with 7.9% in urban areas (AGVSAN, 2009: 4). Furthermore, in 2007, the net rate of schooling was 80.7% in urban areas compared to 74.1% in rural areas, whereas the rate of literacy for individuals aged over 15 years was 59.6% and 26.5% for urban and rural areas respectively (INSAE, 2009).

There is a strong spatial dimension to rural poverty in Benin. In fact, according to data from the INSAE (2009), the North has the highest rate, 71.8%, of rural population living on less than one dollar a day compared with 56.5% for the Centre and 60.1% for the South. The North has also the highest rate of rural population living below the monetary (39.9% compared with 32.1% in the Centre and 34.3% in the South) and nonmonetary (53.9% compared with 41.9% in the Centre and 45.7% in the South) poverty lines. The net rate of schooling and literacy is also weak in the North compared to the Centre and the South of the country. The percentage of the population living in food insecurity is 13% (in the Centre) and 15.3% (in North) (AGVSAN, 2009).

Concerning the gender distribution of poverty in Benin, rural poverty is more prevalent in male-headed households than female-headed households. Thus, in 2006, the incidence of non-monetary poverty was 42.3% in male-headed households compared with 34.6% for female-headed households (SCRP, 2007). Therefore, male-headed households are 1.3 times poorer than female-headed households. Regarding monetary poverty, households headed by men are 1.1 times poorer than those headed by females (SCRP, 2007).

There is a positive correlation between the levels of poverty and the size of the household. Indeed, following SCRP (2007), in 2006, the incidence of nonmonetary poverty was 1.3 times higher in households with more than six individuals than in those with less than three individuals.

Poverty has a negative and significant correlation with the education level in Benin. In other words, poverty decreases as the education level increases. Thus, according to SCRP (2007), households headed by someone with no formal education are 2.5 times more likely to suffer from nonmonetary poverty than those headed by a person with primary education. This ratio is 10.8 when households are headed by someone with secondary education and 29.2 for higher education. The ratio ranges from 1.1 to 5.5 for income poverty (SCR, 2007).

Concerning the relationship between poverty and the employment of the household’s head, AGVSAN (2009: 76) states that the weakest monthly incomes per capita, below the national average of 20,593 FCFA, are amongst households engaged in agro-pastoral activities (subsistence agriculture, fishing and livestock), handicraft and small businesses. Following the
same author, among the households practicing agriculture as the main or secondary activity, those that do not use any improved inputs (apart from seeds) make up a high proportion of the households in food insecurity (18%) or food insecurity risk (18%) than those using improved inputs, 10% and 11% respectively. Furthermore, households whose head does not belong to a farmer’s organization are also more represented among households in food insecurity (16%) or food insecurity risk (16%), than those belonging to an organization, with 10% for both rates.

In summary, poverty is widespread in Benin and rural areas suffer from a substantially greater prevalence of poverty than urban areas.

### 2.2.2. Agriculture in Benin’s economy

Agriculture is the cornerstone of Benin’s economic development. The sector employs 70% of the active population, represents 80% of export income and contributes 32.6% to the Gross Domestic Product (GDP) (AGVSAN, 2009: 21). It is characterized by the predominance of small-scale farming systems, with low productivity due to weak access to improved inputs (seed, fertilizer, and pesticides) and poor management skills. The average size of the farm is estimated at 1.7 ha for 7 people, and 34% of farms cover less than 1 ha, whilst only 5% of the farms in the south and 20% in the north have more than 5 ha (MAEP, 2008: 10).

Livestock’s contribution to the agricultural GDP is roughly 15% to 18% (AGVSAN, 2009: 21). Data from the Ministry of Agriculture of Benin (DE/MAEP, 2008: 40) show that the national production of meat for 2007 was roughly 59,000 tons. This production represents an average consumption of 7.75 kg of meat per capita per annum. By including the import of frozen meat, the real meat available in 2008 was estimated at 67,800 tons which is equivalent to an average national consumption of 9.09 Kg per capita per annum. This animal protein consumption is below the annual average for sub-Saharan Africa (12.5 kg per capita per annum) and the minimum standard recommended by the FAO for developing countries (21 kg per capita per annum) (MAEP, 2008: 90). These figures illustrate a potential market for selling supplementary animal products, especially poultry.

### 2.3. Poultry sector in Benin

#### 2.3.1. Poultry production in Benin

There are two types of poultry keeping systems in Benin: modern poultry farming and village poultry farming. Modern poultry farming concerns about 355 producers located in peri-urban areas with more than 600,000 birds (layers, pullets and meat chickens) (UNAP, 2008), mainly in the Southern part of Benin. This poultry farming is based on imported races (meat and layer hen), whilst inputs (imported or domestic) are often used. Modern poultry farming’s contribution to the national production of eggs is estimated at 78% (PADAP, 2003), whilst it also provides
roughly 5% of the national chicken offer. The level of bio-security in this system is moderate to high (PADAP, 2003). Meat and eggs from modern poultry farming system are less competitive than imported products. Avian influenza reduced its production in 2004 and 2005 (Sodjinou et al., 2007, Tokannou et al., 2008).

Regarding village poultry, productivity is very low compared to high-input systems. For example, and as stated in section 1.1.2, the productivity is 50 eggs per year for local hens with an average of 0.04 kg compared to 220 for improved hens with an average of 0.06 kg as weight (DE/MAEP, 2008). However, more than 8 households out of 10 own poultry at the national level, and it is only the Ouémé and Alibori provinces which have below 80% (61% and 71% respectively) (AGVSAN, 2009).

Village poultry is facing mainly disease problems, notably Newcastle disease. Following DE/MAEP (2008: 46), Newcastle disease rages all year round and in all regions of Benin. In 2007, it peaked (morbidity and mortality rate) from January to March before stagnating between April and October. Another peak was observed in November. The rate of vaccination of poultry against Newcastle disease was estimated at 10.9% at the national level in 2007 (DE/MAEP, 2008: 51). The highly pathogenic avian influenza (HPAI) has been detected in Africa since February 2006, and in December 2007 in Benin (DE/MAEP, 2008: 51), mainly in villages surrounding the Capital Porto-Novo. However, HPAI did not reached villages in which this research took place.

Unfortunately, the supplies from traditional as well as modern poultry farming (roughly 13,000 tons at national level) do not cover the domestic demand for poultry products (between 15,000 and 16,000 tons per annum at the national level) (Chrysostome and Sodjinou, 2005). To fill the gap between supply and demand in poultry products, Benin imports meat and eggs from various countries. The European Union is the main supplier of frozen poultry products to Benin, with more than 90% of the imports (OBOPAF, 2004).

2.3.2. Overview of policy for poultry development in Benin

The history of policy for poultry production in Benin can be subdivided into three main periods. During the first period, from 1960 to 1972, the state’s policy mainly targeted (i) the mastering of enzootic diseases, especially Newcastle disease and avian cholera, (ii) the improvement of indigenous races through the introduction of improved cockerel with the support of Israeli cooperation (iii) the training of extension agents. In this framework, in 1964, the Rhode Island chicken was imported and introduced in many villages as an improvement on the local chickens. However, this program collapsed due to a lack of appropriate strategies (Chrysostome and Sodjinou, 2005).

The second period, from 1972 to 1990 (a period of socialism during which only Marxism-Leninism was tolerated as a political doctrine by the state), is characterized by the creation and
the nationalization of enterprises and projects, such as the Livestock development company (SODERA, Project ADB-Modern Poultry farming); the creation of the National office of Pharmacy with a veterinary department that aimed to ensure the better supply of inputs to poultry-keepers; the Benin-Libya Arab company with its Poultry promotion project, which led to only one hatchery (the hatchery of Pahou, near Cotonou district). During this period, the poultry sector, like all other sectors, did not escape the downfall due to the economic crisis.

The third period, from 1990 to today, is characterized by political reforms and especially the structural adjustment program (SAP). Up to the late 1990s, the government’s activities in the poultry sector mainly targeted modern poultry production. In the village poultry sector, government activities were limited to the introduction of improved cockerel and preventive care, i.e. mostly the vaccination of poultry against Newcastle disease.

Since the early 2000s, the government of Benin has chosen poultry as one of the priority sectors. For this purpose, the concrete strategy for the subsector is described in the Strategic Plan for Agricultural Sector improvement (PSRSA) (MAEP, 2008). Thus, PSRSA states that the government aims to improve both the quantity of poultry products produced and the productivity of modern and traditional chicken and guinea fowl. In other words, its objective is to increase the production of modern poultry meat from 1,000 tons in 2006 to 2,000 tons in 2011, and family poultry from 9,100 tons in 2006 to 18,200 tons in 2011, i.e. a 100% increase in both types of poultry production (MAEP, 2008). The main actions targeted in order to achieve this result are, among others: (i) to organize Research-Development on the productivity of hens and guinea fowl; and (ii) to support the poultry producer for effective prophylaxis and the treatment of poultries. This mainly concerns village poultry, the training of VPVs and their support by providing them with veterinary facilities (vaccines and medicine mainly against Newcastle disease).

Note that other development agencies have also been involved in village poultry development since the late 1990s, as stated in section 1.1.2.

2.4. Microfinance sector in Benin

- Microfinance systems

There are two types of microfinance systems in Benin: traditional (or informal) and modern (or formal). Informal saving and credit unions in Benin include mainly “tontine” group and “banquiers ambulants” (mobile banking). In practice, in the tontine group, the members used to meet periodically (weekly, monthly, etc.) and some of them had a rotating system: the first saving is for one member, the second saving during the second meeting is for another member, and so on. The last saving is often used to pay for the operational costs of the group. Regarding mobile banking; so called mobile bankers move from door to door, often daily, in order to collect
money from people who wish to save. After 31 shares, the saver takes thirty shares, whilst the mobile banker takes one share.

Nowadays, these traditional systems remain in rural as well as urban areas; and many of MFIs’ clients (e.g., 81 % FINADEV and 89 % PADME, two of the large MFIs in Benin) also belong to *tontine* groups (Matul, 2000). Kalala and Ouedraogo (2001) found that there were 440 informal microfinance providers in Benin, whilst a more recent survey conducted by AgeFIB26 indicated that there were 1,400 to 1,800 informal financial service providers in Benin, mainly saving and credit unions (Helms et al., 2005).

The modern and formal MFI can be categorized into three mains groups: credit and saving unions, credit-only MFI, NGOs and donor projects with a microfinance component. Credit and saving unions dominate the microfinance industry in Benin and amongst them, FECECAM is the largest network.

Credit-only institutions are the second largest players in the microfinance industry in Benin. They include, among others, FINADEV (which belongs to a private commercial Bank named Financial Bank), PADME (*Programme d’Appui au Développement des Micro-Entreprises*), and PAPME (*Programme d’appui aux Petites et Moyennes Entreprises*). PADME and PAPME are World Bank supported projects. By the end of 2001, credit-only institutions provided 34% of all loans in the microfinance industry in Benin (Ouattara, 2003).

International NGOs and donor projects with a microfinance component are numerous and some of them are small NGO supported by donor agencies. These projects have outstanding loans which represent less than 5% of the microfinance market.

Despite its relatively small size, Benin remains the country with the highest number of MFIs in the UEMOA27 region. A survey carried out by the Ministry of Finance of Benin in October 2002 estimated that there were 1,192 MFIs in Benin (INSAE, 2007).

- **Government strategies in microfinance sector**

Despite the increase in the number of microfinance institutions in Benin, poor households and micro-enterprises still have poor access to credit. Indeed, most of the FMI focus their activity on large and small urban areas where the probability of loan repayment is high. The problem here is that it is very costly for lenders to operate in rural areas and it is therefore difficult to remain profitable. Because of this situation, the government of Benin decided to create the National Fund of the Microfinance (FNM) by decree No 2006-301 on June 27th, 2006. The aim of the FNM is to reinforce the financial and operational capacities of microfinance institutions in order to increase the population’s access to financial services, at low cost, necessary for the

---

26 AgeFIB: *Agence de Financement des Initiatives à la Base* (NGO)
27 UEMOA: *Union Economique et Monétaire Ouest Africaine*
development of income generating activities. The FNM’s intervention is carried out through five strategic institutions that cover different geographical areas of the country.

This government’s microfinance project (*programme de Microcrédit aux Plus Pauvres, MCPP*) aims to provide micro-credit to the poorest or underserved populations. The loans vary from FCFA 30,000 to FCFA 50,000 for the poor and very poor population (with 2% as interest rate), and between FCFA 2 and 5 millions for micro-enterprises. On December 31st 2008, 395,901 recipients received a total amount of FCFA 16.5 billion (Attanasso, 2009). This credit, although small, can contribute to the alleviation of extreme poverty especially amongst women. However, according to Helms et al. (2005), encouraging the distribution of more credit through mechanisms like a national fund may be at cross-purposes with the goal of alleviating poverty. They think that subsidizing this credit may cause additional harm to poor borrowers by saddling them with unpaid debts.

**Microfinance and rural sector**

A survey carried out by the Ministry of Finance shows that MFI s have reached roughly 500,000 people, which represents about 15% of the active population of Benin (INSAE, 2007). Regarding the Consortium ALAFIA (2010), the clientele is comprised of 47.9% females, 49.6% men and 2.5% groups or associations. Concerning sectors of activities reached by the micro-credit in 2007, 2.5% was for animal production, 1.9% for handicraft, 18.3% for agriculture, 68.1% for the trade, and 9.2% for others (services, manufacture, etc.) (Consortium ALAFIA, 2010).

In 2007, only roughly 18% of small scale farmers and 2% of livestock-keepers had access to credit (SCRP, 2007). In rural areas, most of the MFI s lent less than FCFA 500,000. This amount is very low for agricultural activities that require equipment (MMFPMEJF, 2007).

In our sample (table 2.4), considering the access to credit, four types of households is identified (cf. chapter 5): the households which received poultry-based microfinance (34% of the households), those which received non-poultry-based microfinance (20% of the households), those which received poultry-based and non-poultry-based microfinance (2%) and those which receive no credit (45%). A household is considered as participant in a given microfinance program when at least one member participated in the program. It should be noted that in some households, one member may have an aversion to risk (i.e. does not take credit) when another member participates in a microfinance program. In this case, the household is considered as participant in microfinance program of the latter. We do not have cases where all household members refused to take loan.
Chapter 3.
Factors influencing the adoption of village poultry improvement technologies in Benin

3.1. Introduction

The adoption of technological innovations in agriculture has attracted considerable attention among development economists for several decades. Indeed, the diffusion of improved agricultural technology is the most effective means of improving agricultural productivity and reducing poverty and food insecurity (Feder et al., 1985; Minten and Barrett, 2008).

Concerning village poultry, the improvement of its performance requires changes in breeders’ behavior regarding the activity, notably the use of some technologies often used in intensive poultry farming. These technologies were promoted through the community-based management (CBM) and other projects, including henhouse and chick-house construction using locally available materials, improved cockerels, poultry vaccination, and improved feed. However, the introduction of these new technologies has met with only partial success. Indeed, some of them (e.g. henhouse) are widely used by poultry-keepers, while others (e.g. improved cockerels) have not had much success. Understanding the reasons that underlie this situation is necessary in order to contribute to an efficient dissemination of the technologies. This information is important to prioritize the factors that affect adoption decisions and to provide insight into pathways to increase the awareness and use of village poultry improvement technologies.

The objective of this chapter is to analyze the socioeconomic and institutional factors which influence the adoption of these technologies. To achieve this, a binary choice model (logit) was used (section 3.2). The analysis of the results of this model is preceded by a description of village poultry-keepers (section 3.3). The analysis of the results from the logit regression (section 3.4) indicate that the adoption of village poultry improvement technologies is influenced not only by institutional factors (especially access to credit, contact with extension services and availability of a village poultry vaccinator), but also breeders’ experience (education level and participation in CBM) and the breeders’ general awareness level of, and access to, the technologies.

3.2. Methodology

3.2.1. Modeling village poultry improvement technologies adoption

Two types of technology adoption exist, namely individual (farm-level) adoption and aggregate adoption. Following Feder et al. (1985), adoption at the level of the individual farmer is defined as the degree of use of a new technology by the farmer when he has full information about the new technology. Aggregate adoption is measured by the aggregate level of use of a specific new
Factors influencing the adoption of village poultry improvement technologies in Benin

technology within a given geographical area or a given population (Feder et al., 1985). This study mainly targets the former, i.e. the adoption of village poultry technologies at the farm-level.

The basic problems faced by farmers when it comes to innovation are choices and tradeoffs. Differences in reaction result from the fact that producers do not have the same resource endowments, they have different objectives and preferences, and they often have different educational and socio-economic backgrounds (Tambi et al., 1999). As a consequence, some producers may use the technology while others may not. In such circumstances, farmers’ responses to the innovation or new technology can be explained using the theory of the maximization of expected utility. In other words, the decisions of the farmer in a given period are assumed to be derived from the maximization of expected utility (or expected profit) subject to constraints (e.g. credit). Following this theory, a farmer will adopt a given technology if the expected utility obtained from the new technology exceeds that of the old one (Chebil et al., 2009).

To explain this better, let $U_{i1}$ represent the expected utility that a given farmer $i$ would receive from adopting a new technology and $U_{i0}$ the expected utility gained from adopting the traditional farming practice. The $i^{th}$ farmer adopts the new technology if $U_{i1} > U_{i0}$. Following Verbeek (2004: 192), for each farmer $i$, we can write the utility difference between adopting and not adopting as a function of observed characteristics, $x_i$, and unobserved characteristics, $\varepsilon_i$, say. Assuming a linear additive relationship, for the utility difference we obtain $y_i^* = U_{i1} - U_{i0}$:

$$ y_i^* = x_i'\beta + \varepsilon_i $$

(3.1)

Because $y_i^*$ is unobserved, it is referred to as a latent variable. In the case of village poultry improvement, the decision to adopt or not adopt a given technology can be framed as binary-choice models, which assume that individuals are faced with a choice between two alternatives: the technology is adopted ($y_i = 1$) or not adopted ($y_i = 0$). These models (often derived from equation 3.1.) essentially describe the probability that $y_i = 1$. The general functional form is defined by (Wooldridge, 2005: 592):

$$ P(y_i = 1 | x_i) = G(x_i, \beta), $$

(3.2)

where $G$ is a function with a value strictly between zero and one. Verbeek (2004: 191) argues that, usually, one should restrict attention to functions of the form $G(x_i, \beta) = F(x_i'\beta)$. As $F(.)$ also has to be between 0 and 1, it seems natural to choose $F$ to be some distributional function.

In the innovation adoption literature, various nonlinear functions have been suggested for the function $F$ in order to make sure that the probabilities are between zero and one. The most widely used are the standard normal distribution function which results in the probit model:
Chapter 3

\[ F(w) = \Phi(w) = \int_{-\infty}^{w} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}t^2\right) dt , \]  (3.3)

and the standard logistic distribution function which leads to the logit:

\[ F(w) = L(w) = \frac{e^{w}}{1 + e^{w}} = \frac{e^{x'\beta}}{1 + e^{x'\beta}} . \]  (3.4)

with \( w = x'\beta \).

In most applications, the choice between these two models does not seem to make much difference (Greene, 2008: 774). Indeed, the two distributions are very close to each other, except at the tails. Maddala (1983: 23) argues that the results using the probit and the logit method are not likely to be very different, unless the samples are large (so that we have enough observations at the tails). Following Greene (2008: 774) and Amemiya (1981), it is difficult to justify the choice of one distribution or another on theoretical grounds, unless there are practical reasons for favoring one or the other in some cases for mathematical convenience. In this study, the logit model was used to identify the factors which influence the adoption of village poultry improvement technologies.

3.2.2.  Factors affecting innovation adoption and hypothesis

- Type of factors that can affect innovation adoption

Farmers’ decisions to adopt a new agricultural technology in preference to alternative (old) technologies depend on complex factors. In the innovation adoption literature, especially in animal health management decisions, these factors can be regrouped into five categories (Chilonda and Van Huylenbroeck, 2001): (i) characteristics specific to small-scale farmers (e.g. age, attitudes, knowledge, objectives); (ii) characteristics specific to their farms (e.g. availability of land, water, labor, income, and the size of the livestock resource); (iii) economic factors (markets for outputs and inputs, the level of input and product prices); (iv) institutional setting (veterinary delivery system, infrastructure, credit, information sources, and extension services); and (v) biophysical factors (diseases, parasites, and climatic factors).

All these categories of factors are summarized in a conceptual model of factors which influence decisions made by farmers in village poultry improvement technology adoption (figure 3.1).
Factors influencing the adoption of village poultry improvement technologies in Benin

- **Hypothesized factors influencing village poultry producers’ adoption decision**

Independent variables used in this study include the gender, age, education of the breeder, household size, access to credit, village status (experimental or non-experimental village) and the regional dummy. These variables are listed in table 3.1 along with hypotheses on how each characteristic might affect the adoption of village poultry technologies.

Concerning **gender**, we use the gender of the farmer rather than using the gender of the household head (the conventional practice in most adoption studies). This allows us to examine the behavior of female farmers in both female- and male-headed households. In rural areas of Benin, female farmers often have a labor constraint. Thus, we assume that they will be less likely to adopt the technologies, i.e. the variable gender will have a positive sign.

Following Sall et al. (2000), **age**, a proxy for farming experience, implies that knowledge gained over time from working in an uncertain production environment may help in evaluating information, thereby influencing adoption decisions. In this study, the relationship between age and adoption is expected to be positive for young farmers and negative for old farmers. In other words, we assume that producers are opened to new technologies until a certain age after which they become less open until they reach old age. To allow this nonlinear relationship, the square of the breeder’s age is included in the adoption model. The effect of age, on the probability of adopting a given technology, is inversely U-shaped if the value of age that maximizes the linear prediction falls within the range of age (which is 18 to 90 in this study).
According to Feder et al. (1985), farmers with better *education* are often earlier adopters of modern technologies and apply modern inputs more efficiently. Education may enhance the farmer’s ability to efficiently allocate inputs across competing uses, and to select the “best” technology mix (Polson and Spencer, 1991). This variable is supposed to have a positive influence on the adoption of village poultry technologies.

In the village poultry technologies adoption model, we use *household size* as a simple measure of labor availability. We assume that this factor will have a positive effect on the adoption of poultry technologies, since adopting new technology often implies a need for additional labor. Indeed, following Feder et al. (1985), new technologies may increase the seasonal demand for labor, so that adoption is less attractive for those with limited family labor or those operating in areas with less access to labor markets.

### Table 3.1. Hypothesized determinants of breeders’ decision to adopt poultry improvement technologies

<table>
<thead>
<tr>
<th>Variables</th>
<th>Label (and measure)</th>
<th>$H_0$ sign</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPVIL</td>
<td>Experimental village (1=yes, 0 = no)</td>
<td>+</td>
<td>Breeders in experimental villages have more information about the technologies, and are more likely to adopt them</td>
</tr>
<tr>
<td>GENDER</td>
<td>Gender of the breeder (1 = male, 0=female)</td>
<td>+</td>
<td>Females often have a labor constraint and are less likely to adopt the technologies</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (Years)</td>
<td>+</td>
<td>Producers are open to new technologies until a certain age after which they become less open until they reach old age</td>
</tr>
<tr>
<td>AGE2</td>
<td>Square of AGE ([years]$^2$)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>EDUC</td>
<td>Formal education of the breeder (1=educated, 0=none)</td>
<td>+</td>
<td>Farmer’s education increases the ability to understand the benefit of the technologies</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>Household size</td>
<td>+</td>
<td>Labor availability increases the willingness to adopt the technologies</td>
</tr>
<tr>
<td>CREDIT</td>
<td>Obtained credit (1=yes, 0 = no)</td>
<td>+</td>
<td>Breeders who have access to credit are more likely to use the new technologies</td>
</tr>
<tr>
<td>REGION</td>
<td>Region (1=North, 0=South)</td>
<td>±</td>
<td>The effect regional dummy can be positive or negative</td>
</tr>
</tbody>
</table>

The *access to credit* can have a positive effect on the adoption of various village poultry technologies. Indeed, Feder et al. (1985) show that credit is an important determinant for the adoption of new technologies. The main problem, however, is that measuring access to credit is not an easy task. Doss (2006) argues that the best measure would be whether there is a source of credit available to the farmer. This would mean a source of credit for which the farmer is eligible, at a reasonable cost, both in terms of time and money. However, Doss (2006) notes that such a measure is often unavailable, but one solution is to include a measure of whether the farmer had ever received credit. This measure is still not perfect, but it is a better measure of access than the simpler question of whether the farmer used credit in the current period (Doss, 2006). Therefore, we used this method in this study and we assume that access to credit will have a positive effect on the adoption of village poultry technologies.

A dummy variable is included in the adoption model for the *village status*, with 1 for experimental village, 0 otherwise. Being in villages where CBM has been implemented will
facilitate farmers’ initial exposure to the technologies. This will increase the farmer’s propensity to adopt the technology, i.e. the sign of this variable is assumed to be positive.

Finally, a dummy variable is included for regions (1=North and 0=South), which allows us to detect some cultural variability and to control for agro-climatic differences that could affect the profitability of adopting the technologies. This variable can have either a positive or negative effect on the adoption of technologies.

3.2.3. Model and data used

- **Model used**

In this study, the logit model is used to identify the factors which influence the adoption of village poultry improvement technologies. The independent variables are described in section 3.2.2. The output variables are the adoption status (adopt or not adopt), where the adopter is the person using the technology at the time of the survey (i.e. agricultural campaign 2008-2009). Thus, in the model, a given outcome variable was coded with the value 1 to indicate that the farmer adopts the technology and zero otherwise. Five types of technologies were targeted: improved cockerel, henhouse, chick-house, improved feeding, and vaccination of village poultry.

The estimation of the coefficients is carried out with the maximum likelihood (ML) method using the econometrics software Stata/SE 10.0 for Windows (StataCorp, 2007). As the model might suffer from heteroskedasticity, i.e. a non-constant variance of the variable y given the covariates x, we use an ML procedure that automatically accounted for this.

- **Hypothesis tests and marginal effects**

The likelihood-ratio test is used for the test of the null hypothesis that all of the coefficients associated with independent variables are simultaneously equal to zero. The statistical significance of single covariates, $H_0: \beta_k = 0$, is tested using the z-statistic, which is equal to the estimate divided by its standard error defined as: $z = \hat{\beta}_k / \hat{\sigma}_{\hat{\beta}_k}$ (Wooldridge, 2005: 596).

The test of joint significant of AGE and AGE2 is performed using the Likelihood-ratio test. This test compares the log-likelihood values of the models with and without the factors AGE and AGE2 and tests whether this difference is statistically significant. The LR test statistic is given by:

$$
\xi_{LR} = 2[\log L(\hat{\theta}) - \log L(\tilde{\theta})],
$$

(3.5)

where $\hat{\theta}$ is the unrestricted ML estimator (i.e. with factors AGE and AGE2) and $\tilde{\theta}$ is the constrained ML estimator (i.e. without factors AGE and AGE2) obtained by maximizing the log-likelihood function $\log L(\theta)$. 

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The set of parameters $\beta$ in equation 3.3 reflects the impact of changes in $x$ on the probability (Greene, 2008: 772) of adoption of the technology. One way to interpret these parameters (and to ease comparison across different models) is to consider the partial derivative of the probability that $y$ equals one with respect to a continuous explanatory variable, $x_k$, say. For the logit model used in this study, we obtain:

$$\frac{\partial L(x' \beta)}{\partial x_k} = \frac{e^{x'\beta}}{(1 + e^{x'\beta})^2} \beta_k$$  \hspace{1cm} (3.6)

Five of the variables used in the logit model (cf. table 3.1) are dummy variables. For these dummy variables, equation 3.5 is inappropriate, since the derivative is with respect to a small change. The appropriate marginal effect for these binary independent variables, say, $d$, would be (Greene, 2008: 775):

$$\text{Prob}[y = 1 | \bar{x}_{(d)}, d = 1] - \text{Prob}[y = 1 | \bar{x}_{(d)}, d = 0]$$  \hspace{1cm} (3.7)

where $\bar{x}_{(d)}$ denotes the means of all the other variables in the model.

- **Data used**

Data used in this chapter were collected from 303 households selected in the North and South of Benin (cf. section 2.1.2). In each of the households, all members that produce poultry were interviewed. When the head of the surveyed household is married, poultry farming is practiced by the wife (wives) or the husband or both. For this reason, the sample size of the poultry producers (table 3.2) is higher than the number of households surveyed.

Data were collected through focus group discussion as well as individual interviews (cf. section 2.1.2). These data mainly concern farmers’ perceptions of various poultry improvement technologies (village poultry vaccination, chick-house and henhouse building, improved cockerels and making feed for poultry) and on community-based management of village poultry. Quantitative data concerned the farmer’s characteristics and those that are specific to their farms, economic factors and the institutional setting.

**Table 3.2. Distribution of the sample according to the participation in CBM**

<table>
<thead>
<tr>
<th>Region</th>
<th>Non-participant of non-experimental village</th>
<th>Non-participant of experimental village</th>
<th>Participant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>51</td>
<td>84</td>
<td>93</td>
<td>228</td>
</tr>
<tr>
<td>North</td>
<td>39</td>
<td>55</td>
<td>83</td>
<td>177</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>139</td>
<td>176</td>
<td>405</td>
</tr>
</tbody>
</table>
3.3. Description of poultry-keepers

Females represent about 42% of producers, with 26% in the North and 55% in the South (table 3.3). The difference between the two regions can be explained by the fact that females in the North are relatively less involved in poultry farming, compared to the South. The analysis, according to participation in CBM (table 3.4), shows that females represent 48% of the participants interviewed, compared to 42% and 31% for non-participants of experimental villages and non-experimental villages, respectively. As was pointed out by peasants during the focus group discussions, the difference between the two regions is due to the fact that in the studied villages in the North, poultry rearing was essentially a man’s activity. However, since the introduction of CBM, the number of women involved in this activity has increased. To put it another way, CBM has had an effect on the involvement of women in village poultry rearing in the North.

Table 3.3. Some characteristics of poultry-keepers per region

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>South (n=228)</th>
<th>North (n=177)</th>
<th>Total (n=405)</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender of the breeder (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>54.8</td>
<td>26.0</td>
<td>42.2</td>
<td>$\chi^2=33.96^{***}$</td>
</tr>
<tr>
<td>Male</td>
<td>45.2</td>
<td>74.0</td>
<td>57.8</td>
<td></td>
</tr>
<tr>
<td>Age of the livestock-keeper (year)</td>
<td>42.3 (14.1)</td>
<td>46.1 (13.7)</td>
<td>44.0 (14.0)</td>
<td>$F=7.17^{***}$</td>
</tr>
<tr>
<td>Education (% of formal educated)</td>
<td>29.8</td>
<td>36.2</td>
<td>32.6</td>
<td>$\chi^2=1.82$</td>
</tr>
<tr>
<td>Access to credit for poultry (%)</td>
<td>30.7</td>
<td>44.6</td>
<td>36.8</td>
<td>$\chi^2=8.32^{***}$</td>
</tr>
<tr>
<td>Household size (number)</td>
<td>7.0 (3.6)</td>
<td>9.4 (4.8)</td>
<td>8.0 (4.3)</td>
<td>$F=34.71^{***}$</td>
</tr>
</tbody>
</table>

( ): Figures in parentheses are standard deviations; F = F-test from one-way analysis of variance.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

Table 3.4. Some characteristics of poultry-keepers according to the participation in CBM

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Non-participant of non-experimental village (n=90)</th>
<th>Non-participant of experimental village (n=139)</th>
<th>Participant (n=176)</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender of the breeder (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>31.1</td>
<td>42.4</td>
<td>47.7</td>
<td>$\chi^2=6.7^{**}$</td>
</tr>
<tr>
<td>Male</td>
<td>68.9</td>
<td>57.6</td>
<td>52.3</td>
<td></td>
</tr>
<tr>
<td>Age of the livestock-keeper (year)</td>
<td>43.0 (15.4)</td>
<td>43.0 (13.7)</td>
<td>45.3 (13.5)</td>
<td>$F=1.3$</td>
</tr>
<tr>
<td>Education (% of formal educated)</td>
<td>35.6</td>
<td>24.5</td>
<td>37.5</td>
<td>$\chi^2=6.5^{**}$</td>
</tr>
<tr>
<td>Access to credit for poultry (% of yes)</td>
<td>5.6</td>
<td>5.0</td>
<td>77.8</td>
<td>$\chi^2=225.6^{***}$</td>
</tr>
<tr>
<td>Household size (number)</td>
<td>7.8 (4.2)</td>
<td>8.2 (4.1)</td>
<td>8.0 (4.6)</td>
<td>$F=0.3$</td>
</tr>
</tbody>
</table>

( ): Figures in parentheses are standard deviations; F = F-test from one-way analysis of variance.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

The average age of the farmers is 44 years, with the producers in the North (46 years) being on average older than those in the South (42 years). The average age of participants and non-participants in the CBM does not differ significantly.
Concerning the level of education, roughly 33% of the producers have received formal education, with about 36% for the producers in the North compared to 30% for those in the South. Among the participants in CBM, 38% had received a formal education compared to 25% and 36% for non-participants of experimental and non-experimental villages, respectively.

About 37% of the producers received credit for poultry production. The difference between the North and South is not significant at the 5% level. In other words, there is independence between regions and access to credit. However, there is dependence between access to credit and the participation in CBM. Indeed, about 78% of the participants in CBM received credit compared to 5% and 6% for the non-participants of experimental and non-experimental villages, respectively.

The average size of producers’ households is 8 people and households in the North are on average larger. Household size is almost the same (about 8 people per household) for participants and non-participants CBM.

### 3.4. Determinant of adoption of village poultry improvement technologies

#### 3.4.1. Determinant of adoption of village poultry vaccination

- **The technology: modern treatment of village poultry diseases**

Modern treatment is based on the use of vaccine and other medicine commonly used in intensive poultry production. It is a preventive measure, which supposes that the vaccination should be done before the birds are host to the disease, in particular ND. The vaccination is performed by VPVs and sometimes by veterinarians.

About 47% of the breeders used to vaccinate their poultry, with about 64% for participants in CBM compared to 31% for non-participants in non-experimental villages (table 3.5). This rate of poultry vaccination is higher than the value found at the national level. Indeed, at the national level, the rate of poultry vaccination is low. For example, in 2007, the national average rate of vaccination was 11% (DE/MAEP, 2008: 51).

- **Traditional methods of treatment of poultry diseases**

Traditional and modern methods are used to treat poultry diseases. Traditional methods are based on plants or products purchased in local markets. The plants most used by the interviewed farmers are vernonia (*Vernonia amygdalina*), chili pepper (*Capsicum frutescens*) and basilica (*Ocimum basilicum*). The products usually purchased on the market include capsules, antibiotics28, and glutamate (a white powder often used for seasoning sauces). Parasites are usually treated with ash and reptiles are driven out by surrounding the henhouse with carbide from welding shops. Table 3.5 shows that approximately 53% of the surveyed farmers only treat

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28 Products normally used for the treatment of human disease
Factors influencing the adoption of village poultry improvement technologies in Benin

their birds with traditional methods, with about 36% for participants in CBM compared to 63% and 69% for non-participants of experimental and non-experimental villages, respectively.

Approximately 38% of the farmers only use modern vaccination, whilst 10% use both traditional medicines and modern vaccination. About 53% of the participants in CBM only use modern treatment compared to 29% for non-participants of experimental villages and 21% for non-participants of non-experimental villages. Eleven percent of participants in CBM used to combine modern and traditional treatment compared to 8% and 10% for non-participants of experimental and non-experimental villages, respectively. Producers who used to combine vaccination with traditional treatment methods do not find that vaccination fully prevents ND from attacking their poultry. They, therefore, combine it with other remedies which they find to have a preventive effect in their specific local context (Thomsen, 2005: 76).

Table 3.5. Method of treatment of poultry and rate of vaccination abandonment

<table>
<thead>
<tr>
<th>Treatment methods</th>
<th>Non-participant of non-experimental village (n=90)</th>
<th>Non-participant of experimental village (n=139)</th>
<th>Participant (n=176)</th>
<th>Total (n=405)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>68.9</td>
<td>63.3</td>
<td>36.4</td>
<td>52.8</td>
</tr>
<tr>
<td>Modern</td>
<td>21.1</td>
<td>28.8</td>
<td>52.8</td>
<td>37.6</td>
</tr>
<tr>
<td>Traditional and modern</td>
<td>10.0</td>
<td>7.9</td>
<td>10.8</td>
<td>9.6</td>
</tr>
<tr>
<td>Vaccination of village poultry</td>
<td>31.1</td>
<td>36.7</td>
<td>63.6</td>
<td>47.2</td>
</tr>
<tr>
<td>Appreciation of the vaccination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfied</td>
<td>56.8</td>
<td>85.3</td>
<td>84.2</td>
<td>80.5</td>
</tr>
<tr>
<td>Little satisfied</td>
<td>43.2</td>
<td>14.7</td>
<td>15.8</td>
<td>19.5</td>
</tr>
</tbody>
</table>

- **Results of the logistic regression**

The results in table 3.6 indicate that residing in experimental villages (variable EXPVIL) has a positive and significant effect on the adoption of vaccination (at 5% level). In other words, the probability of adopting poultry vaccination is higher for the producers in the experimental villages than those in the non-experimental villages. The observation of the marginal effect indicates that the implementation of the community based management in a village will, *ceteris paribus*, increase the probability of village poultry vaccination by 14%.

This result shows that the CBM, as an approach based on community, facilitates the farmers’ initial exposure to the vaccination and thus their appreciation of its benefits. This confirms the observation of Doss (2006), who notes that the first reason why farmers do not adopt improved technologies is simply that they are not aware of them – or that they are not aware that the technologies would be beneficial for them. This is in agreement with the findings of Ahuja et al. (2003), who show that in rural Orissa (a state of India), the demand for animal health services was linked to the general awareness level of the household, but was not linked to the rate of subsidy of veterinary services or products if they existed. In other words, poor livestock owners
show willingness to pay for animal health services, but may have lower awareness of, and access to, the services (Kryger et al., 2010: 33).

As expected, the education has a positive and significant effect (at 1% level) on the adoption of village poultry vaccination. This means that producers who have received a formal education are more likely to vaccinate their poultry than uneducated farmers. The probability that an educated person will adopt village poultry vaccination is, _ceteris paribus_, 19% higher than an uneducated person. Therefore, an improvement in the education level of producers can increase the adoption of vaccination.

### Table 3.6. Factors influencing the adoption of village poultry vaccination: results of logit regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Coefficient</th>
<th>z</th>
<th>Marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPVIL</td>
<td>Experimental village (1=yes, 0=no)</td>
<td>0.554**</td>
<td>1.96</td>
<td>0.137**</td>
</tr>
<tr>
<td></td>
<td>(0.282)</td>
<td></td>
<td></td>
<td>(0.068)</td>
</tr>
<tr>
<td>GENDER</td>
<td>Gender of the breeder (1=male, 0=female)</td>
<td>0.095</td>
<td>0.35</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>(0.269)</td>
<td></td>
<td></td>
<td>(0.067)</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (Years)</td>
<td>0.020</td>
<td>0.47</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td></td>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>(AGE&lt;sup&gt;2&lt;/sup&gt;/100</td>
<td>Square of AGE ([years]&lt;sup&gt;2&lt;/sup&gt;) divided by 100</td>
<td>-0.033</td>
<td>-0.76</td>
<td>NN</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDUC</td>
<td>Formal education of the breeder (1=educated, 0=none)</td>
<td>0.790***</td>
<td>2.94</td>
<td>0.193***</td>
</tr>
<tr>
<td></td>
<td>(0.269)</td>
<td></td>
<td></td>
<td>(0.063)</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>Household size</td>
<td>-0.026</td>
<td>-0.97</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td></td>
<td></td>
<td>(0.007)</td>
</tr>
<tr>
<td>CREDIT</td>
<td>Obtained credit (1=yes, 0=no)</td>
<td>1.289***</td>
<td>5.13</td>
<td>0.308***</td>
</tr>
<tr>
<td></td>
<td>(0.251)</td>
<td></td>
<td></td>
<td>(0.055)</td>
</tr>
<tr>
<td>REGION</td>
<td>Region (1=North, 0=South)</td>
<td>0.650***</td>
<td>2.62</td>
<td>0.161***</td>
</tr>
<tr>
<td></td>
<td>(0.248)</td>
<td></td>
<td></td>
<td>(0.060)</td>
</tr>
<tr>
<td>(Constant)</td>
<td>Constant</td>
<td>-1.419</td>
<td>-1.46</td>
<td>NN</td>
</tr>
<tr>
<td></td>
<td>(0.973)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_N = 405; LR chi2(8) = 72.17***; Log likelihood = -244.61; Pseudo R<sup>2</sup> = 0.129; NN = Not Need Likelihood-ratio (LR) test for the joint significant of AGE and AGE2: LR chi-square = 1.75

Value of AGE that maximizes the linear prediction = 32.33;

( ): Figures in parenthesis are standard errors

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

Access to credit has a positive and significant impact (at 1% level) on the adoption of poultry vaccination. In other words, access to credit increases the probability that farmers will adopt village poultry vaccination by 31%. Compared with the other variables used in our logit model, access to credit has the highest impact on vaccination adoption. This result is in accordance with Feder et al. (1985) who argue that credit is an important determinant for the adoption of new technologies. This implies that improving producers’ access to credit will increase the adoption of poultry vaccination.

As shown in Table 3.6, gender has no significant effect (at 5% level) on the adoption of village poultry vaccination. Therefore, the adoption of village poultry vaccination does not depend on
the sex of the producer. This result is in line with Doss and Morris (2001) who found that, controlling for everything else, male and female farmers made the same adoption decisions.

In addition, the regional dummy has a positive and significant effect on the adoption of village poultry vaccination at 1% level. This result indicates that village poultry-keepers surveyed in the northern part of the country have a higher propensity to adopt poultry vaccination than the breeders in the southern part. Based on the marginal effect (table 3.6), one can say that the probability of village poultry vaccination is, *ceteris paribus*, 16% higher in the North than in the South. This can be explained by three main reasons. First, in the North, farmers are more involved in cattle rearing where vaccination is frequently used. Therefore, a certain propensity to vaccinate animal exists for these peasants.

Second, the difference between the two regions can also be explained by the difference in the vaccine supply system used. Indeed, in the North, VPVs are regrouped in a network (or associations) with the support of the project PAMRAD (Project Rural Development in Atacora and Donga provinces). The main role of these associations is to purchase and sell vaccines (and other veterinary products) to their members. They used to purchase their products from private veterinarians.

Third, the difference between the North and the South can also be explained by the difference in the profitability of village poultry vaccination. Indeed, Cordel (2003) shows that the profit of the VPVs was higher in the North (FCFA 2,000 to FCFA 2,500 to vaccinate 100 chickens) than the South (FCFA 500 to vaccinate 100 chickens). Also, the monthly gross margin for VPVs in the North can reach FCFA 15,000 compared to FCFA 2,500 for VPVs in the South. This difference in the monthly margins of the VPVs can be explained by the quantity of vaccines marketed.

- **Peasants’ appreciation of poultry vaccination**

About 81% of the producers (who used to vaccinate the birds) are satisfied with village poultry vaccination, with 84% of participants and 57% in non-participants of non-experimental villages (table 3.5). This is in accordance with the results obtained by Thomsen (2005: 76) who indicated that farmers recognize vaccination as being the most effective means of combating ND, thus making this measure highly prioritized by farmers. However, smallholders make their own adjustments regarding the application of the measure, e.g. they may not be capable of accessing the funds needed for vaccinating every time their VPV decides to run a campaign, or they disagree as to when it should be done (Thomsen, 2005: 76).

In addition, about 19% of breeders who vaccinate their birds are not satisfied with the VPV interventions for various reasons. First, certain producers indicate that the VPV are not always available, mainly because they have no salary. Second, in the surveyed villages in Northern Benin, producers blame the VPVs because they do not respect appointments. Third, some VPVs
do not have equipment (for storage of the vaccines) and products (vaccines and antibiotic) are often unavailable at their level.

Fourth, during the focus group discussion, producers stated that some VPVs do not master the timing for poultry vaccination, e.g. they vaccinate the birds when some are already infected or are ill. This bad timing increases the mortality rate of several birds, notably chickens. This then results in a decrease in the motivation of farmers to use modern treatment. Thomsen (2005: 76) reports similar results stating that sometimes VPVs wait until they hear rumors of an approaching epidemic before they announce a campaign.

Fifth, the place to purchase the vaccines is far from the village. As a result, the VPVs increase the price of the vaccine to cover the cost of travelling and buying the vaccines. This situation reduces the producers’ ability to purchase the vaccines because of their low financial power.

3.4.2. Determinants of adoption of chick-house and henhouse

- The technologies

During the implementation of poultry-based projects, a model of the henhouse (constructed with locally available materials) is often suggested to the producers. However, farmers are not obliged to adopt this model type. Each producer can adapt the model to his own conditions and financial means. By allowing producers to adapt henhouses to their personal circumstances means that projects leave room for variability in the henhouses built. However, following Thomsen (2005: 72), it is expected that the henhouses are in line with certain regulations regarding the optimal functioning of the structure. For example, henhouses have to have a door which is high enough for people to enter for cleaning purposes, as well as for some form of ventilation. Henhouses also have to contain nests, perches, drinking bowls and feeders, although such equipments are often badly kept. In some cases, breeders also possess modest cages for egg laying (photo 3.2).

During our study, we found that henhouses (\textit{koklo kpo} in local language \textit{Fon}) are made of clay (photo 3.1(a)) and oil palm branches. Birds are also sheltered in small cages, like the ones used for transporting birds by poultry traders (photo 3.1(b)). These cages are often hung from the ceiling of the room or placed on the ground. Chick-houses are made of ribs of palm and are often cone-shaped.

Normally, each poultry keeper builds his henhouse himself, although women sometimes ask for their husband’s assistance. Young boys also participated in the building of the henhouse for the head of the household.

Table 3.7 shows that about 29% of the breeders have chick-houses, with 47% for participants in CBM compared to 14% and 17% for non-participants of experimental and non-experimental villages, respectively. Henhouses are available for 70% of poultry-keepers, with 90% for participants in CBM compared with 48% of the farmers of non-experimental villages.
Table 3.7. Chick-house and henhouse possession by participants and non-participants in CBM

<table>
<thead>
<tr>
<th></th>
<th>Non-participant of non-experimental villages (n=90)</th>
<th>Non-participant of experimental villages (n=139)</th>
<th>Participant (n=176)</th>
<th>Total (n=405)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possess chick-house</td>
<td>16.7</td>
<td>13.7</td>
<td>46.6</td>
<td>28.6</td>
</tr>
<tr>
<td>Possess henhouse</td>
<td>47.8</td>
<td>59.0</td>
<td>89.8</td>
<td>69.9</td>
</tr>
</tbody>
</table>

Photo 3.1. Henhouse in local available materials for poultry only (a) and mixed housing (b)

Photo 3.2. Egg laying house made from the branches of a palm oil tree, with eggs and hen (a) and duck (b) inside

- **Results of the logistic regression**

Residing in an experimental village has a positive and significant effect on the adoption of henhouses (table 3.8). This implies that producers from experimental villages are more likely to adopt henhouse buildings than producers from non-experimental villages. Based on the marginal effect of this variable, one can say that the implementation of community-based management in a village increases the probability of henhouse adoption by 19%.

The gender of the breeder significantly influences the adoption of chick-houses as well as the adoption of henhouses, where male producers are more likely to provide shelter for their birds.
than female breeders. In other words, the probability of henhouse adoption tends to be, *ceteris paribus*, 14% higher for male breeders (13% in case of chick-houses). This can be explained by the fact that male producers have greater access to labor and financial means than females. This result is in accordance with Houndonougbo (2005) who found that male smallholders have less financial constraints when constructing poultry housing than their female counterparts. Furthermore, Thomsen (2005: 74) noted a difference in size and solidness between the structures raised by men and women. Thomsen (2005: 74) argues that this difference can partly be explained by the actual physical work needed for construction with women depending on male assistance, whether it is their husbands or a hired work force. In the latter case, women tend to compromise on the quality and size of the housing due to their limited financial means. However, even if female smallholders do not need to raise funds to pay outsiders to construct a poultry house for them, but can instead receive assistance from their husbands, they still end up with relatively small structures in awkward places, sometimes quite far away from their homes (Thomsen, 2005: 74).

### Table 3.8. Factors influencing the adoption of chick-houses and henhouses: results of logit regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Henhouse</th>
<th>Chick-house</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Coefficient</td>
<td>z</td>
</tr>
<tr>
<td>EXPVIL</td>
<td>Experimental village (1=yes, 0 = no)</td>
<td>0.921***</td>
<td>(0.284)</td>
</tr>
<tr>
<td>GENDER</td>
<td>Gender of the breeder (1 = male, 0=female)</td>
<td>0.726**</td>
<td>(0.300)</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (Years)</td>
<td>0.041</td>
<td>(0.046)</td>
</tr>
<tr>
<td>(AGE²)/100</td>
<td>Square of AGE ([years]²) divided by 100</td>
<td>-0.043</td>
<td>(0.047)</td>
</tr>
<tr>
<td>EDUC</td>
<td>Formal education of the breeder (1=educated, 0=none)</td>
<td>0.443</td>
<td>(0.307)</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>Household size</td>
<td>0.016</td>
<td>(0.032)</td>
</tr>
<tr>
<td>CREDIT</td>
<td>Obtained credit (1=yes, 0=no)</td>
<td>1.784***</td>
<td>(0.338)</td>
</tr>
<tr>
<td>REGION</td>
<td>Region (1=North, 0=South)</td>
<td>0.601**</td>
<td>(0.284)</td>
</tr>
<tr>
<td>(Constant)</td>
<td>Constant</td>
<td>-2.107**</td>
<td>(1.047)</td>
</tr>
</tbody>
</table>

For Henhouse: N = 405; LR chi-square(8) = 90.94***; Log likelihood = -202.35; Pseudo R² = 0.184; Value of AGE that maximizes the linear prediction = 45.79 years; LR test for the joint significant of AGE and AGE²: LR chi-square = 0.61
For Chick-house: N = 405; LR chi-square (8) = 75.76***; Log likelihood = -204.68; Pseudo R² = 0.156; Value of AGE that maximizes the linear prediction = 48.65 years; LR test for the joint significant of AGE and AGE²: LR chi-square = 0.40

( ): Figures in parenthesis are standard errors, NN = Not Need

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

The difference between males and females regarding the adoption of henhouses may also be explained by the prestige associated with henhouses, which is sought by men. Thus, as noted by Thomsen (2005: 74), to some men, a large and attractive looking poultry house may act as an important status symbol, so they are more than willing to invest considerable funds and work
into its construction. This is not the case for women who have more economic vision. Indeed, to the women, poultry keeping is mostly about making money, or reinforcing social positions, and therefore a henhouse has a mainly functional purpose (Thomsen, 2005: 74).

As in the case of vaccination, access to credit is the main factor which influences the adoption of henhouses and chick-houses. Indeed, access to credit has a positive and significant influence on the adoption of henhouses and chick-houses. To put it another way, the probability of henhouse adoption increases by, \textit{ceteris paribus}, 29\% when farmers have access to credit, and 31\% in the case of chick-houses.

Household size has a positive and significant effect on the adoption of chick-houses. The adoption of chick-house is less attractive for farmers with limited family labor. Increasing the household size by 1 person increases, \textit{ceteris paribus}, the probability of adopting chick-houses by 2\%.

Finally, the regional location has a significant effect both on the adoption of chick-houses, and on the adoption of henhouses. While, \textit{ceteris paribus}, households in the North have an 11\% higher probability of having a henhouse, they have, \textit{ceteris paribus}, a 29\% lower probability of having a chick-house compared to households in the South. The higher probability for adopting henhouses in the North may be explained, as mentioned above, by the fact that the producers in the North have greater manpower and greater access to credit and they are therefore more inclined to adopt the technology.

3.4.3. Determinant of adoption of improved feeding

- \textit{The technology}

The improved feed (served mainly to adult birds) is just a combination of various locally available products such as corn, bones or shells of snails, small fishes, soy, salt and by-products of peanut oil. These products are ground down and are then served to birds in the morning, noon and/or afternoon, depending on the producer's means.

About 31\% of the breeders make improved feed to their birds, with 50\% for the participants in CBM. These measures are considerably less used by non-participants, particularly in non-experimental villages. Indeed, only 7\% of the non-participants of non-experimental villages make improved feed to their birds, compared with approximately 22\% of non-participants of experimental villages.

It is worth noting that traditionally, products such as chopped cassava, corn, bran of corn, rice, millet/sorghum, bean and by-products of \textit{gari} (flour from cassava), are used to feed birds. For chicks, cereals are first crushed and for ducklings these crushed grains are coated with oil. Snails and worms (obtained from cattle excreta put in a pot for 3 to 4 days) are also used as feed.
Termites are essentially used for the feeding of small guinea-fowl and sometimes chicks and ducklings.

- **Results of the logistic regression**

The results of the logistic regression (table 3.9) indicate that households living in experimental villages have a significantly (at 1% level) higher probability of adopting improved feed. It follows that producers who are in the experimental villages adopt this technology more often than producers in the non-experimental villages. The implementation of CBM in a village increases the probability of using improved feed by 24%.

The age of the breeders has a significant effect on the adoption of improved feed. As the signs of both the coefficient of age as well as $\text{AGE}^2$ (square of age) are significantly different from zero, the probability of adoption of improved feed depends nonlinearly on the breeder’s age. The value of age that maximizes the linear prediction is 40.55 years. This implies that the effect of age on the probability of improved feed is inversely U-shaped. In other words, until the age of 40.55, the probability of adopting improved feed increases with the breeder’s age, but after 40.55, the probability of adopting improved feed decreases with the breeder’s age. To put it another way, producers are open to the use of improved feed for village poultry production until the age of 40.55, after which they become less receptive to the technology.

Table 3.9. Factors influencing the adoption of improved feed: results of logit regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Coefficient</th>
<th>z</th>
<th>Marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPVIL($^{(1)}$)</td>
<td>Experimental village (1=yes, 0 = no)</td>
<td>1.728***</td>
<td>3.69</td>
<td>0.235***</td>
</tr>
<tr>
<td>GENDER($^{(1)}$)</td>
<td>Gender of the breeder (1 = male, 0=female)</td>
<td>0.175</td>
<td>0.57</td>
<td>0.031</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (Years)</td>
<td>0.107*</td>
<td>1.78</td>
<td>-0.002</td>
</tr>
<tr>
<td>(AGE$^2$/100</td>
<td>Square of AGE ([years]$^2$) divided by 100</td>
<td>-0.137**</td>
<td>-2.11</td>
<td>NN</td>
</tr>
<tr>
<td>EDUC($^{(1)}$)</td>
<td>Formal education of the breeder (1=educated, 0=none)</td>
<td>0.680**</td>
<td>2.21</td>
<td>0.129**</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>Household size</td>
<td>0.072**</td>
<td>2.45</td>
<td>0.013**</td>
</tr>
<tr>
<td>CREDIT($^{(1)}$)</td>
<td>Obtained credit (1=yes, 0=no)</td>
<td>1.567***</td>
<td>5.57</td>
<td>0.304***</td>
</tr>
<tr>
<td>REGION($^{(1)}$)</td>
<td>Region (1=North, 0=South)</td>
<td>-1.535***</td>
<td>-5.01</td>
<td>-0.259***</td>
</tr>
<tr>
<td>(Constant)</td>
<td>Constant</td>
<td>-5.126***</td>
<td>-3.79</td>
<td>NN</td>
</tr>
</tbody>
</table>

N = 405; LR chi-square(8) = 112.28***; Log likelihood = -193.34; Pseudo $R^2$ = 0.225

Likelihood-ratio (LR) test for the joint significant of AGE and AGE$^2$: LR chi-square = 8.30**

Value of AGE that maximizes the linear prediction = 40.55

( ): Figures in parenthesis are standard errors, NN = Not Need

*** Significant at 1%, ** Significant at 5%, * Significant at 10%
Factors influencing the adoption of village poultry improvement technologies in Benin

Education has a positive and significant effect on the adoption of improved feed. This indicates that more educated farmers are more willing to adopt the technology than less educated farmers. In other words, the probability of adopting the technology increases by about 13% when the farmer has a formal education.

Similar to the technologies analyzed above, the adoption of improved feed is highly and significantly influenced by the producer’s access to credit. To put it another way, breeders’ access to credit might increase the probability of adopting this technology by 30%.

Finally, the breeders in the North have a significantly lower probability of adopting improved feed. This means that breeders in the South are more willing to adopt improved feed than those in the North. Based on the marginal effect of this variable, one can say, *ceteris paribus*, that the probability of improved feed adoption is 16% higher in the South than the North.

### 3.4.4. Determinant of adoption of improved cockerels

Improved males are only introduced for chickens through the “improved cockerels operation” (Cordel, 2003, Chrysostome and Sodjinou, 2005). The aim of this introduction is to improve indigenous chicken performance: quantity of eggs produced and quantity of meat. Only 10% of the surveyed farmers have improved cockerels, with roughly 11% in the experimental villages and 6% in the non-experimental villages. In the experimental villages, about 14% of the participants in CBM have improved cockerels compared to 9% of non-participants.

The logistic regression analysis (table 3.10) indicates that the household size has a positive and significant effect (at 5% level) on the adoption of improved cockerels. This indicates that households with more members adopt improved cockerels more likely than those with less household members. The marginal effect of this variable is relatively low; an additional person increases the probability of improved cockerel adoption by 0.6%.

Contrary to the four technologies analyzed above, access to credit does not have a significant effect on improved cockerel adoption. In contrast, the regional location has a significant effect on the adoption of improved cockerel; where producers in the South are, *ceteris paribus*, more likely to adopt this technology than those in the North.

In reality, and as the above results indicated, the improved cockerel was not widely adopted (compared to the four other technologies analyzed above) because of various reasons, e.g. low resistance to disease and the socio-cultural role of indigenous poultry. Indeed, the study of Cordel (2003) and Chrysostome and Sodjinou (2005) showed that “improved cockerels operation”, financed by the Beninese Government, has produced interesting results: improvement in the weight of indigenous chickens and number of eggs laid. However, the main drawback of this operation is that it did not take into account the failures of similar operations
carried out in the 1960s when the introduction of new genes seriously impacted the phenotypic diversity, which is strongly valued in rural areas (Chrysostome and Sodjinou, 2005). Thus, the chickens with red, white or black plumage sought for traditional and ritual ceremonies became rare. Some farmers, therefore, consciously abandoned cockerels without care or killed them. Moreover, Chrysostome and Sodjinou (2005) state that the crossbreed obtained from the first generation are not adapted to traditional poultry rearing practices; consequently the rate of loss was high which is mainly due to the birds’ low level of resistance.

Table 3.10. Factors influencing the adoption of improved cockerel: results of logit regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Coefficient</th>
<th>z</th>
<th>Marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPVIL</td>
<td>Experimental village (1=yes, 0 = no)</td>
<td>0.625</td>
<td>1.19</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>Gender of the breeder (1 = male, 0=female)</td>
<td>0.165</td>
<td>0.39</td>
<td>0.011</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (Years)</td>
<td>0.123</td>
<td>1.37</td>
<td>0.002</td>
</tr>
<tr>
<td>(AGE(^2))/100</td>
<td>Square of AGE ((years(^2)) divided by 100</td>
<td>-0.131</td>
<td>-1.33</td>
<td>NN</td>
</tr>
<tr>
<td>EDUC</td>
<td>Formal education of the breeder (1=educated, 0=none)</td>
<td>0.514</td>
<td>1.22</td>
<td>0.037</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>Household size</td>
<td>0.098**</td>
<td>2.59</td>
<td>0.006***</td>
</tr>
<tr>
<td>CREDIT</td>
<td>Obtained credit (1=yes, 0=no)</td>
<td>0.077</td>
<td>0.20</td>
<td>0.005</td>
</tr>
<tr>
<td>REGION</td>
<td>Region (1=North, 0=South)</td>
<td>-1.893***</td>
<td>-3.92</td>
<td>-0.123***</td>
</tr>
<tr>
<td>(Constant)</td>
<td>Constant</td>
<td>-5.931***</td>
<td>-2.98</td>
<td>NN</td>
</tr>
</tbody>
</table>

N = 405; LR chi-square (8) = 30.36***; Log likelihood = -117.57; Pseudo R\(^2\) = 0.114

Likelihood-ratio (LR) test for the joint significant of AGE and AGE\(^2\): LR chi-square = 2.15

Value of AGE that maximizes the linear prediction = 46.50; NN = Not Need

**: Figures in parenthesis are standard errors
*** Significant at 1%, ** Significant at 5%, * Significant at 10%

As stated by Chatterton and Chatterton (1982), the problem may be in the communication between government institutions and farmers (but also researchers), with the role of farmers (and researchers) being underestimated in the technology transfer process. The farmers may be socially and politically conservative, but they live a life that requires them and their families to take risks and to cope with the vagaries of the weather and markets in a manner that agricultural administrators would find extremely stressful (Chatterton and Chatterton, 1982). Kryger et al. (2010: 54) argue that without considering the social and cultural aspects of smallholders’ livestock keeping, there is a risk that development interventions will fail to provide smallholders with the appropriate assistance. This is because where livestock keeping is concerned, smallholders do not act only on the basis of economic rationales, but also seek to fulfill their social and cultural obligations (Kryger et al., 2010: 54).

29 The main breeds used were Rhode Island Red and Plymouth Rock
3.5. Conclusion and implications

In conclusion, the CBM approach brings some changes to the peasant’s behavior concerning the management of village poultry farming. Farmers from experimental villages are also more likely to adopt various village poultry improvement technologies such as vaccination, improved feed, henhouses and chick-houses. This indicates that when the farmer has the information and technical support through an approach based on the community, i.e. CBM, he can change his behavior over the traditional poultry farming to obtain increased profits. The main policy implication of this result is that the government or development actors must invest in the dissemination of information and assistance on village poultry improvement in particular through community-based approaches.

Our results also suggest that decisions concerning the adoption of village poultry technologies primarily depend on access to resources, notably credit. The main policy implication is that it might be important for the government or development actors to improve the access to credit for farmers.

Education also has a positive and significant effect on the adoption of village poultry improvement technologies. Farmers in the South are more likely to adopt improved cockerel, chick-houses and improved feed than those in the North. On the other hand, producers in the North are more likely to adopt henhouses and poultry vaccination than those in the South.

The difference in adoption of village poultry vaccination between the two regions is due to the fact that in the North, producers are more involved in cow rearing where the utilization of vaccination is frequent. The difference between the two regions can also be caused by the difference in the profitability of village poultry vaccination, which is higher in the North than in the South. This is also related to the strategy used in the North, VPVs are organized in associations and also private veterinarians are involved in the supply of vaccines and other veterinary products to VPVs. The policy implication of this result is that it might be beneficial to organize VPVs in associations also in other regions of the country and to put them in touch with private veterinarians.
Chapter 4.
Impact of community-based management on village poultry producers’ performance in Benin

4.1. Introduction

This chapter aims to assess the contribution of community-based management of poultry to the performance of village poultry production in Benin as well as the factors which influence this performance. In practice, the quantification of the performance status of farmers is useful in many ways. It facilitates comparisons across similar economic units, and can help to determine the under-utilization or over-utilization of factor inputs. A performance study can help to identify possibilities to raise productivity, i.e. increasing output without increasing the resource base or developing new technologies.

A natural measure of this performance is a productivity ratio which is the ratio of outputs to inputs, whereby greater values of this ratio are related to better performance (Coelli et al., 2005: 1). Performance can simply be profit, i.e. revenue minus cost, but it can also be judged using the concept of economic efficiency, which is generally comprised of two parts: technical efficiency and allocative efficiency.

In this study, village poultry performance is assessed using profitability, productivity and efficiency. In addition, this chapter assesses the determinants of village poultry survival rate. Indeed, the main problem facing farmers in village poultry production is a high mortality rate. Identifying the factors which influence birds’ survival rate can facilitate the implementation of the actions which aim to improve poultry survival.

Three types of methods have been developed (section 4.2): the enterprise budget approach for profitability analysis (cf. results in section 4.3), censored regression to analyze factors which influence the poultry survival rate (cf. results in section 4.4), and stochastic frontier analysis for assessing farmers’ technical efficiency (cf. results in section 4.5). This chapter finishes with a conclusion in section 4.6. It should be noted that this chapter, like chapter 3, is based on individual breeders, which is in contrast to chapter 5, which mainly concerns breeders’ households. Also, the profitability and efficiency analysis concern the three types of poultry (chickens, ducks and guinea fowl) targeted in this study, while the analysis of the determinants of the survival rate concerns only chickens, which is the main bird vaccinated by breeders.
4.2. Methodology

4.2.1. Analytical framework for profitability assessment

Profitability analysis is based on the enterprise budget approach. This method provides useful information that can be used by various actors (producers, extension service, development agencies, and other advisers) to make decisions. It simply entails estimating the production costs as well as the revenue for a particular product on a period of reference. In this study, the period of reference, or observation period, is a year (i.e. July 2008 through June 2009) and the indicators calculated are the gross product, the returns over variable costs, and the net returns.

The gross product, gross output, or total revenue ($TR_i$ in FCFA) takes into account the changes of livestock due to sales and purchases, and through inventory at the beginning and at the end of the observation period. For a farmer $i$, the total revenue can be written as:

$$ TR_i = \sum_{j=1}^{3} Tr_{ij} = \sum_{j=1}^{3} [SAE_{ij} + HP_{ij} + (SAB_{ij} - PAB_{ij}) + (BP_{ij} - EP_{ij})] $$

(4.1)

where $Tr_{ij}$ is the total revenue of each poultry type $j$ (chickens, ducks and guinea fowl) during the observation period; $SAE_{ij}$ is the sale of eggs in FCFA for poultry type $j$, $HP_{ij}$ is home consumption and gift in FCFA for poultry type $j$ (valued at the selling price of the period); $SAB_{ij}$ is the sales of poultry type $j$ in FCFA, $PAB_{ij}$ is the purchases of poultry type $j$ in FCFA; $BP_{ij}$ is the value of the poultry type $j$ at the end of the observation period and $EP_{ij}$ is the value of the poultry type $j$ at the beginning of the observation period. The values of a given bird at the end (June 2009) and at the beginning (July 2008) of the observation period equal the number of birds available multiplied by the average selling price prevailing on the nearest rural market at the same moment.

Return over variable costs ($RVC_i$), for a farmer $i$, can be formulated as follows:

$$ RVC_i = TR_i - VC_i $$

(4.2)

where $VC_i$ is the variable costs, i.e. expenses that vary with output within the observation period. In this study, variable costs include veterinary and medicine costs (including traditional treatment costs, vaccination, drugs, and henhouse decontamination) and feeding costs. Feed costs correspond to the cost of improved feed used plus the opportunity cost of feed from the producer’s own production. The latter was estimated by the producer herself based on what she would have paid if she had purchased the feed at the nearest market.

The net return or profit ($NR_i$) is defined as the difference between the total revenue ($TR_i$) and the total costs ($TC_i$) of production. For a given farmer $i$, it can be written as:

$$ NR_i = TR_i - TC_i = TR_i - (VC_i + OCL_i + FC_i) $$

(4.3)
where, $OCL_i$ represents the opportunity cost of family labor, $FC_i$ is the fixed costs, i.e. those costs that do not vary with the level of output. In this study, these include the depreciation of various equipment (henhouses, chick-houses, troughs, etc.), and the depreciation of parent birds. Family labor ($FL$, in man-days) was valued at its opportunity cost ($FLC$), which is what the family labor could earn if engaged in the next most lucrative employment. To do so, the time spent by adults and children was converted into man-days multiplied by the price of the man-day that prevailed in the research area at the time of the investigations. The conversion of labor into man-days was based on the weights suggested by Adegbola and Sodjinou (2003): children aged 5-9 years count as 0.6 of an adult, whilst children aged 10-14 count as 0.8.

Apart from these indicators ($TR$, $RVC$ and $NR$), the average productivity of inputs (labor, veterinary and medicine, capital, feed) and parent birds was calculated. The productivity is defined as the ratio of output ($TR$) to input, whereby larger values of this ratio are associated with better performance.

### 4.2.2. Analytical framework to assess factors affecting poultry survival rate

- **Dependant variables**

Losses constitute an important problem in village poultry production. Indeed, they have negative influences on the value creating process based on using village poultry as an economic resource. The losses can be due to several factors of which disease, particularly Newcastle disease (ND), is the most important. ND affects more chickens than other types of village poultry and prevails all year round, but causes the highest mortality rate during the change from the dry to the rainy season and vice versa. At the national level in 2007, there was a peak (morbidity and mortality rate) from January through March, followed by stagnation between April and October (DE/MAEP, 2008: 46). The other factors of losses are related to predators and road accidents. It is important to understand the factors that reduce these losses, i.e. the factors that contribute to the improvement of the birds’ survival rate.

In this study, and as stated in section 4.1, the analysis of the determinants of survival rate only concerns chickens. Two types of survival rates were calculated: chicks’ survival rate and overall (chicks + adult poultry) survival rate. Chicks’ (less than one month of age) survival rate ($CSR$) is given by:

$$CSR_i = \frac{1 - (NCD_i / TNC_i)}{CSR_i}$$

where $NCD_i$ is the number of chicks of breeder $i$ that died during the observation period and $TNC_i$ is the total number of chicks hatched during the same period (July 2008 through June
The overall survival rate (SR), or chicken’s survival rate\(^{30}\), can be defined as (for a given producer \(i\)):

\[
SR_i = [1 - (\text{Loss}_i / (\text{FB}_i + \text{TNC}_i + \text{CP}_i))] \tag{4.5}
\]

with \(\text{Loss}_i\) being the number of chickens (chicks and adults) which died during the observation period, \(\text{FB}_i\) the flock size at the beginning of the observation period, \(\text{TNC}_i\) the total number of chicks hatched during the observation period and \(\text{CP}_i\) the total number chickens purchased during the observation period.

- **The model used**

The survival rates calculated in equations 4.4 and 4.5 are censored at both upper and lower limit, i.e. they range from \(L_1 = 0\) (no bird survived) to \(L_2 = 1\) (no bird died). For chickens, roughly 1% and 6% of the breeders have 0 and 1 as the survival rate, respectively. For chicks, roughly 5% and 9% of the breeders have 0 and 1 as the survival rate, respectively. Since our dependant variables are bounded below by \(L_1=0\) and above by \(L_2=1\), the appropriate analytical approach is the two-limit Tobit model (also termed censored regression). This model is specified as follows (Rosett and Nelson, 1975):

\[
y_i = x_i^t \beta + \varepsilon_i
\tag{4.6}
\]

and

\[
y_i = L_1 \text{ if } y_i \leq L_1
\]

\[
= y_i \text{ if } L_1 < y_i < L_2
\]

\[
= L_2 \text{ if } y_i \geq L_2
\]

where \(i\) indicates the breeders; \(x_i\) represents the vector of the independent variables; \(\beta\) is the unknown parameters; \(\varepsilon_i\) is the error term which is assumed to be normally distributed with a mean 0 and variance \(\sigma^2\); and \(y^*_i\) is the latent variable (also called index variable) that is not observed for values less than zero and greater than one. The latter (\(y^*_i\)) satisfies the classical linear model assumption; in particular, it has a normal, homoskedastic distribution with a linear conditional mean (Wooldridge, 2005: 605).

For the censored regression of the equation 4.6, there are different types of conditional mean functions, notably the expected value of the latent variable \(y^*_i\):

\[
E(y^*_i \mid x_i) = x_i^t \beta \tag{4.7}
\]

Following Green (2008: 871), if the data are always censored, then the result of equation 4.7 will usually not be useful. Concerning the second conditional mean function, for an observation randomly drawn from the population, which may or may not be censored, we have:

\(^{30}\) From now on we will use the expression “chicken survival rate” instead of “overall survival rate”
\[
E(y_i \mid x_i) = x_i'\beta + \sigma \frac{\phi(Z_{i,1}) - \phi(Z_{i,2})}{\Phi(Z_{i,2}) - \Phi(Z_{i,1})}
\] (4.8)

where \( Z_{i,1} = (L_1 - x_i'\beta) / \sigma \) and \( Z_{i,2} = (L_2 - x_i'\beta) / \sigma \); \( \phi(\cdot) \) and \( \Phi(\cdot) \) are the density function and the cumulative distribution function of the standard normal variable. When there are no limits, \( Z_i = x_i'\beta / \sigma \).

The main problem is the choice of the conditional mean functions that should be used for calculating predicted values for the censored regression. According to Green (2008: 872), “intuition suggests that \( E(y_i \mid x_i) \) is correct, but authors differ on this point.”

- **Hypothesized factors determining village poultry survival rate**

The independent variables used in the censored regression were:

- **the availability of chick-houses (CHIKHOUS) and henhouses (HENHOUSE).** Village poultry survival can be affected by natural factors such as rain, but also by predators such as snakes, rats, dogs, cats, and foxes. The availability of shelter can reduce the effect of these factors and increase the poultry survival rate. In particular, overnight housing is an important way to reduce this loss, and housing can be built by using locally available materials at a reasonable cost (Sonaiya and Swan, 2004). Thus, we assume that the availability of chick-houses and henhouses will have a positive effect on the survival rate of chicks and chickens.

- **the improved feeding (IMPFEED).** Apart from better housing, Kyvsgaard et al. (1999) argue that a more intensive feeding of poultry would increase their survival and thus reduce economic losses. Sonaiya and Swan (2004) claim that better nutrition for young stock boosts their immune response to disease challenges and the vaccine response by developing full immunity. We expect the sign of this variable to be positive.

- **the vaccination of poultry (VACCIN).** Following Chrysostome and Sodjinou (2005), in Benin, breeders who vaccinate their birds have low a poultry mortality rate (8% to 20%) compared to those who do not vaccinate (more than 80%). Accordingly, we expect the effect of the vaccination on the poultry survival rate to be positive.

- **expenditure on animal health care (VETERC).** Expenditure on poultry health care (traditional and modern) includes expenses on vet treatment, drugs, and henhouse decontamination. This investment in village poultry disease prevention and treatment can have a positive effect on the poultry survival rate.

- **the distance (DMARKET) to the nearest market (in 100 km).** There is a State or private veterinarian installed near the largest rural market in each district (i.e. Lobogo in the South, Kolokonde in Djougou, and Kassua for Ouake). This could be a source of supply for vaccines and other veterinary products for farmers and VPVs in particular. To account for this, the
distance between the breeders’ houses and the nearest market is used as a proxy for accessibility to veterinary agents as well as access to market. We assume that DMARKET will have a negative sign, meaning that small-scale farmers located far from a market will have a low poultry survival rate. Indeed, the distance to the veterinary agents (from whom the village poultry vaccinator used to buy products) is a decisive factor for determining the degree to which small-scale farmers rely on veterinary services (Chilonda and van Huylenbroeck, 2001).

- **Hypothesis tests and marginal effects**

The maximum likelihood method was used to estimate the censored regression with the econometrics software Stata/SE 10.0 for Windows (StataCorp, 2007). The likelihood-ratio test is used to test the null hypothesis that all coefficients are simultaneously equal to zero. The coefficients \( \beta \) give the signs of the partial effects of each \( x \) on the survival rate, and the statistical significance of \( x \) is determined by whether we can reject \( H_0: \beta = 0 \) at a sufficiently small significance level.

It is worth noting that the censored regression coefficients do not directly give the marginal effects of the independent variables on the survival rate. Following Greene (2008: 673), the marginal effect is given by:

\[
\frac{\partial E(y \mid x)}{\partial x} = \beta \Phi \left( \frac{x' \beta}{\sigma} \right).
\]

(4.9)

**4.2.3. Analytical framework for efficiency assessment**

- **Theoretical framework**

Efficiency can be defined as the degree to which a production process reflects “best practice,” either in an engineering sense or in an economic sense (OECD, 2001). This was suggested by Farrell (1957) and comprises two components namely technical efficiency (TE) and allocative efficiency (AE). TE measures the degree to which available inputs have been converted to output without any price consideration. To put it another way, technical inefficiency corresponds to failure to attain the highest possible level of output given inputs and technology (Bravo-Ureta and Pinheiro, 1993). AE reflects the ability of a farmer to use the inputs in optimal proportions, given their respective prices and the production technology (Coelli et al., 2005). The combination of technical and allocative efficiency yields the economic efficiency, which is a measure of overall performance \( EE = TE \times AE \). It is possible for a farmer to be either technically or allocatively efficient without being economically efficient.

In this study, only technical efficiency has been estimated. Since variations of (input) prices between farms are often mainly due to quality differences, it is usually not possible to estimate cost or profit functions with cross-sectional farm data (Quiggin and Bui-Lan, 1984). Hence, it is
not possible to estimate the cost efficiency or economic efficiency with a cost function or profit function with the data collected in this research.\(^{31}\)

The methods available in the literature for estimating TE can be broadly grouped into two categories; namely parametric and non-parametric approaches. The predominant non-parametric approach uses mathematical programming to measure efficiency and is called Data Envelopment Analysis (DEA). This has the advantage that it can be implemented without making assumptions about the algebraic form of the relationship between outputs and inputs (Coelli et al., 2005). However, DEA is a deterministic approach, and it is therefore unsuitable for analyses in stochastic environments such as free-range poultry production.

The parametric methods are based on the existence of a functional form of the production function and fall into two categories: deterministic and stochastic frontier approaches. Deterministic methods attribute any deviation from the frontier to inefficiency as the DEA. In other words, deterministic methods ignore the fact that output may be affected by random shocks that are not under the control of the farmer (Kumbhakar and Lovell, 2003), which is unrealistic in free-range poultry production. Indeed, even if a farm uses a best practice technique, random errors may not be zero due to errors of measurement, weather, and other factors. Due to the shortcomings of the deterministic methods, the stochastic frontier analysis is often used in empirical studies.

The stochastic frontier analysis (SFA), suggested independently by Aigner et al. (1977) and Meeusen and van den Broeck (1977), is capable of capturing measurement errors and statistical noise. For a given producer \(i\), the stochastic frontier of production can be defined as follow:

\[
y_i = f(x_i, \beta) \exp(v_i - u_i),
\]

where \(y_i\) is the output quantity; \(x_i\) is a \((k \times 1)\) vector of input quantities; \(\beta\) is a vector of parameters to be estimated; \(f(\cdot)\) is a suitable functional form (such as the Cobb-Douglas or translog); \(v_i\) is the random error that captures the effects that are not under the producer’s control and is assumed to be independent and identically distributed as \(N(0, \sigma_v^2)\); and \(u_i \geq 0\) captures the technical inefficiency of the producer and is assumed to be distributed independently of \(v_i\).

The most commonly-used output-oriented TE for a given firm \(i\) is the ratio of observed output to the corresponding stochastic frontier output (Kumbhakar and Lovell, 2003):

\[
TE_i = \frac{y_i}{f(x_i; \beta) \cdot \exp(v_i)} = \exp(-u_i)
\]

\(^{31}\) Note that Kumbhakar and Wang (2006) show how technical and allocative efficiency can be estimated using a primal system consisting of the production function (translog) and first-order conditions of cost minimization. We do not use this because our main objective was to focus on farmers’ technical inefficiency.
If $TE_i = 1$, the production of the firm $i$ falls on the stochastic frontier, which means that the producer is technically efficient. When $TE_i < 1$, the producer is inefficient.

The estimation of a stochastic frontier function can be accomplished by using maximum likelihood (ML) methods if an explicit distribution is assumed for the efficiency component, such as half-normal [$u_i \sim iid N^+(0, \sigma_u^2)$], truncated-normal [$u_i \sim iid N^+(\mu, \sigma_u^2)$], exponential [$u_i \sim iid G(\lambda, 0)$] or gamma [$u_i \sim iid G(\lambda, m)$]. ML estimators have many desirable large-sample (i.e. asymptotic) properties (Coelli et al., 2005).

- **Empirical model**

An important step in efficiency analysis is the choice of the functional form. The most commonly used are the Cobb-Douglas and translog functional forms. The Cobb–Douglas production function makes restrictive assumptions. Indeed, it assumes that (i) the partial production elasticities, as well as the elasticity of scale, are constant and independent of the input mix; and (ii) the elasticity of substitution between each two inputs is one, whereas it can be anywhere from zero to infinity in practice. In contrast, the translog function is a second-order flexible functional form. In this study, we used the translog functional form defined as:

$$
\ln y = \beta_0 + \sum_{k=1}^{4} \beta_k \ln x_k + \frac{1}{2} \sum_{k=1}^{4} \sum_{l=1}^{4} \beta_{kl} \ln x_k \ln x_l + v - u
$$

(4.12)

where we omit the subscript $i$ for the producer to simplify the notation. We impose symmetry in input cross effects by assuming $\beta_{kl} = \beta_{lk}$ to identify these parameters, $v$ and $u$ are defined as in equation 4.10, and:

- $y$ denotes annual poultry production measured in kilogram of chicken equivalent, i.e. $y = TR / Pc$, with $TR$ being the total revenue calculated in equation 4.1 and $Pc$ the average chicken selling price (in FCFA/kg) at the nearest rural market at the end of the observation period (June 2009),
- $x_1$ represents the annual labor spent for poultry production in man-days,
- $x_2$ is the feed cost (cost of improved feed used plus the opportunity cost of feed from the producer’s own production),
- $x_3$ is the annual cost of veterinary treatment and medicine (including traditional treatment costs, vaccination, drugs, decontamination), and
- $x_4$ measures the capital input by taking the annual depreciation of various equipment (henhouses, chick-houses, troughs, etc.) and poultry parents.

Details on the methods used to calculate the input variables $x_1$ to $x_4$ can be found in section 4.2.1.
Chapter 4

Production elasticity and marginal physical products

Based on the translog production function used, we calculate the partial production elasticities and the marginal physical products of the input factors. The partial production elasticity of input $x_k$ is the ratio of the proportionate change in output to the proportionate change in input $x_k$, assuming that all other inputs are fixed. It is defined as:

$$\frac{\partial y}{\partial x_k} = \frac{\partial \ln y}{\partial \ln x_k} = \beta_k + \sum_{l=1}^{4} \beta_{kl} \ln x_l,$$

and we evaluate it at the sample means. The sum of the partial production elasticities represents the elasticity of scale.

The marginal product of input $x_k$ ($MP_k$) is the first partial derivative of the production function with respect to $x_k$. In other words, it is the change in output resulting from an increase in an input by one unit, holding all other inputs constant. We have:

$$MP_k = \frac{\partial y}{\partial x_k} = \frac{\partial \ln y}{\partial \ln x_k} \frac{y}{x_k} = (\beta_k + \sum_{l=1}^{4} \beta_{kl} \ln x_l) \frac{y}{x_k},$$

In this equation, we set $y$ equal to (average) total revenue (TR) so that the MP is in fact marginal value products (MVP) and hence the change in output can be interpreted in monetary terms (FCFA).

It is worth noting that the translog production function, in contrary to the Cobb-Douglas, is often not globally monotonic or globally quasi-concave (see also Greene, 2008). Monotonicity of the production function requires positive marginal products with respect to all inputs and thus non-negative partial production elasticities. Henningsen and Henning (2009) show that the efficiency estimates of the individual farmers cannot be reasonably interpreted if a production frontier is not monotonically increasing. For this purpose, in this study, we impose the monotonicity condition using the method suggested by Henningsen and Henning (2009).

Inefficiency variables

In addition to the measure of the level of technical efficiency, the factors that influence this efficiency can be analyzed. There are two types of approaches that can be used for this purpose: single-stage and two-stage. Kumbhakar et al. (1991) show that the two-stage procedure may give inconsistent parameter estimates, which may lead to inappropriate estimates of technical inefficiency. Due to this shortcoming of the two-stage approach, this study uses the single-stage maximum likelihood procedure to obtain consistent parameter estimates and to identify the determinants of technical inefficiency. In this approach, the parameters of the stochastic frontier and of the inefficiency model are estimated simultaneously, given appropriate assumptions.
Impact of community-based management on village poultry performance in Benin

associated regarding the distributions of $v$ and $u$ (Battese and Coelli, 1995). Following these authors, the mean of technical inefficiency effects, $u$, is defined as:

$$
\mu = \delta_0 + \sum \delta_m z_m 
$$

(4.15)

where the inefficiency term $u$ follows a truncated normal distribution $u \sim N^+(\mu, \sigma_u^2)$. $\delta$'s is the parameter to be estimated, and $z_m$ the farm-specific characteristics. The latter include:

- the gender of the breeder (GENDER), with 1 for males and 0 for females. This variable is used to assess the effect of gender on efficiency. In the literature, the effect of gender on technical efficiency is unclear. Quisumbing (1996) indicates that most of the studies on differences in technical efficiency between male and female farmers found insignificant dummies for the sex of the farmer. That is, female farmers and male farmers have almost the same efficiency, once individual characteristics and input levels are controlled for. This is in line with Adesina and Djato (1997) who also show that the relative degree of efficiency of women is similar to that of men. Alabi and Aruna (2005), in their study of family poultry production in the Niger-Delta (Nigeria), found that inefficiency is less among females than males. They argue that this may be because women are more involved in family production than men, so that they develop superior caring techniques to men. It may also be due to the fact that they stay at home to care for the family poultry more often than men. On the other hand, Akter et al. (2003) show that females are significantly less efficient in poultry production in North Vietnam. The main reason is that females are generally less well educated and have less access to knowledge and information, which might reduce their efficiency. Due to this lack of consensus regarding the effect of gender on efficiency, in this study, we expect the sign of this variable to be either positive or negative.

- the age of the breeder (AGE) in years. In this study, age is supposed to have a positive or negative effect on efficiency. Indeed, the effect of this variable on efficiency is debated in the literature. Thus, Akter et al. (2003) show that age has no significant effect in North Vietnam, but in the South, farms with older household heads have significantly lower inefficiency. Note that, the square of the breeder’s age (AGE2) is also included in the inefficiency model in order to account for a non-linear relationship between age and efficiency.

- the education of the breeder (EDUC), with 1 for educated farmers and 0 otherwise. This variable represents formal schooling. In general in the literature, the effect of education on technical efficiency is often positive. Akter et al. (2003) show that better education of the farmer significantly reduced inefficiency in poultry production in North Vietnam, perhaps because education facilitates better information gathering and application. Also, Coelli and Battese (1996) found that education had a significant positive effect on the technical efficiency of Indian farmers. Also, in a review of various studies carried out on efficiency analysis of developing country agriculture, Bravo-Ureta and Pinheiro (1993) report that farmers’ education tends to
have a positive and statistically significant impact on technical efficiency. In short, for poultry production, we suppose that a high level of formal education will increase efficiency.

- **the access to poultry-based credit (CREDIT), with 1 for farmers who have accessed this type of credit and 0 otherwise.** As noted in section 3.2.2, measuring access to credit is not an easy task. Doss (2006) argues that one solution is to include a measure of whether the farmer has ever received credit. This is the method used in this study and we assume that access to poultry-based credit will have a positive effect on technical efficiency in village poultry production. In fact, access to credit for poultry production may increase the ability to use better quality inputs and services, and may, therefore, increase efficiency. Bravo-Ureta and Pinheiro (1993) show that access to credit tends to increase farmers’ technical efficiency in many circumstances. In contrast, Akter et al. (2003) find that access to credit significantly reduced the efficiency of poultry production in North Vietnam. They argue that, normally, access to credit is expected to have a positive effect on farmers’ efficiency; the opposite result may be due to the purpose for which the credit was used.

- **the community-based management (CBM), with 1 for participants and 0 otherwise; the status of the village (EXPVILL), 1 for experimental village and 0 otherwise.** As stated in the introductory chapter, the community-based management (CBM) serves as a channel for the dissemination of various village poultry improvement technologies, such as village poultry vaccination, chick-house and henhouse building, and improved feed using locally available inputs. We expect that the implementation of CBM in a village will have a positive effect not only on the efficiency of the participating farmers, but also on the efficiency of other breeders living in the experimental villages. Also, participation in CBM is expected to have positive effect on the technical efficiency.

- **the distance (DMARKET) to the nearest market (in km).** The distance to the nearest market (defined in section 4.2.2) is included in the inefficiency model. Indeed, producers who are close to the market have greater access to information related not only to good poultry farming management practices, since there is often a vet living near the largest rural market of each district (as mentioned in Section 4.2.2), but also to output prices (including traders’ preferences) and inputs prices. We expect the distance to market to have a positive sign, meaning that breeders who are located far from market will be less efficient.

**Model estimation and monotonicity condition**

As stated above, the ML method was used to estimate the parameters of the stochastic frontier and the inefficiency model simultaneously. It was assumed that the distribution of the efficiency component would be truncated. The maximum likelihood estimation of 4.12 and 4.15 yields estimators for $\beta$, $\gamma = \frac{\sigma_u^2}{\sigma^2}$ (with $0 \leq \gamma \leq 1$) and $\sigma^2 = \sigma_u^2 + \sigma_v^2$. The value of $\gamma$ is equal to 0 if
there are no technical inefficiency effects and all deviations from the frontier are due to noise (Coelli et al., 2005). If inefficiency exists, $\gamma$ will be different from zero.

We impose monotonicity on our translog frontier production function using the three-step method suggested by Henningsen and Henning (2009). In the first step, the unrestricted stochastic production function, including the inefficiency effects model defined in equations 4.12 and 4.15, is estimated. Then the parameters $\hat{\beta}$ of this production frontier are extracted, as well as their covariance matrix $\hat{\Sigma}_{\beta}$ from the estimation results. In the second step, the restricted $\beta$ parameters are obtained by a minimum distance estimation subject to the monotonicity constraints:

$$\hat{\beta}^0 = \arg\min(\hat{\beta}^0 - \hat{\beta})\hat{\Sigma}_{\beta}^{-1}(\hat{\beta}^0 - \hat{\beta});$$

s.t. $f_i(x, \hat{\beta}^0) \geq 0 \forall i, x.$

In the third step, the efficiency estimates of the farmers are determined as well as the effects of variables explaining technical inefficiency based on the theoretical consistent production frontier. The stochastic frontier model of this step is given by:

$$\ln y = \alpha_0 + \alpha_1 \ln \tilde{y} - u^0 + v^0$$

$$\mu = z'\delta^0$$

where the only ‘‘input variable’’ is the ‘‘frontier output’’ of each firm calculated with the parameters of the restricted model: $\tilde{y} = f(x, \hat{\beta}^0)$. Parameters $\alpha_0$ and $\alpha_1$ allow an adjustment of the restricted production frontier, which gives: $y = e^{\alpha_0} f(x, \hat{\beta}^0)^{\alpha_1}$.

The results obtained and presented in table 4.1 indicate that before the imposition of the monotonicity condition, the model was overall monotonic for 42% of the observations, and was quasiconcave for about 13% of the observations. For each input variable, the monotonicity condition was fulfilled 61% for feed, 69% for labor, 89% for vet and 100% for capital. However, after the imposition, the monotonicity condition for the exogenous variable was fulfilled at 100%, and the translog function was quasiconcave in 269 out of 302 observations (89.1%).

It is worth noting that the stochastic frontier analysis was carried out using the package ‘frontier’ (Coelli, Henningsen, 2010) of R statistical software. The minimization of the distance was performed by using the R package ‘quadprog’ (Turlach + Weingessel, 2010). The package ‘frontier’ also allows us to calculate the marginal effect of a $z$-variable (of equation 4.15) on the technical efficiency. The formula used is the one suggested by Olsen and Henningsen (2011):
\[
\frac{\partial \text{TE}}{\partial z_m} = (1-\hat{\gamma}) \left \{ \frac{\phi \left( \frac{\mu_e - \mu_s}{\sigma_s} \right) e^{-\mu_s^2/2}}{\sigma_s} \phi \left( \frac{\mu_e}{\sigma_s} \right) e^{-\mu_e^2/2} - \frac{\phi \left( \frac{\mu_e}{\sigma_s} \right) e^{-\mu_e^2/2}}{\sigma_s} \phi \left( \frac{\mu_e - \mu_s}{\sigma_s} \right) e^{-\mu_s^2/2} \right \} \delta_m \quad (4.18)
\]

in which \( \phi(\cdot) \) denotes the probability density function of the standard normal distribution, \( \delta_m \) and \( z_m \) are defined in equation 4.15. \( \mu_e = (1-\hat{\gamma})\hat{\mu} - \hat{\gamma}\hat{\sigma} \), \( \sigma_s = \sqrt{\hat{\gamma}(1-\hat{\gamma})\hat{\sigma}^2} \), \( \hat{\sigma} = \hat{\sigma}_u + \hat{\sigma}_v \), \( \hat{\gamma} = \frac{\hat{\sigma}_u}{\hat{\sigma}} \), \( \hat{\sigma}_u \) denotes the estimated variance of the inefficiency term \( u \), \( \hat{\sigma}_v \) represents the estimated variance of the stochastic error term \( v \), \( \varepsilon = u + v \) is the total residual, and \( \hat{\mu} \) is calculated by equation 4.15 using estimated \( \delta \) coefficients. Please note that we define \( \mu_e \) slightly differently to Olsen and Henningsen (2011), because in our study the inefficiency term \( u \) is subtracted from the production frontier, while in their output distance function the inefficiency term is added.

<table>
<thead>
<tr>
<th>Label</th>
<th>Before imposing monotonicity</th>
<th>After imposing monotonicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VET</td>
<td>Veterinary cost</td>
<td>88.7</td>
</tr>
<tr>
<td>LABOUR</td>
<td>Labor</td>
<td>69.2</td>
</tr>
<tr>
<td>CAPITAL</td>
<td>Capital</td>
<td>100.0</td>
</tr>
<tr>
<td>FEED</td>
<td>Feed costs</td>
<td>60.9</td>
</tr>
<tr>
<td>Overall</td>
<td>Joint consideration of all inputs</td>
<td>42.1</td>
</tr>
<tr>
<td>Quasiconcavity</td>
<td></td>
<td>12.6</td>
</tr>
</tbody>
</table>

### 4.3. Production cost structure and profitability of village poultry

#### 4.3.1. Village poultry production cost structure

Table 4.2 shows that participants in community-based management (CBM) have an annual production (about 76 kg), which is significantly higher than non-participants of experimental villages (67 kg) and non-participants of non-experimental villages (47 kg).

The labor costs per kilogram of poultry produced are significantly lower for participants in CBM (FCFA 185 per kg) compared to non-participants (FCFA 251 to FCFA 263 per kg). The feeding cost is higher (but not significantly) for participants than for non-participants. The capital (depreciation) per kilogram of poultry produced is almost the same for the three categories of breeders. Finally, the veterinary costs for participants are considerably higher than for the non-participants of experimental villages, but rather similar to non-participants of non-experimental villages.
The total poultry production cost is on average FCFA 453 per kg of chicken. This cost is lower for participants in CBM (FCFA 423 per kg) than it is for the non-participants of experimental villages (FCFA 476 per kg) and non-experimental villages (FCFA 486 per kg). This finding implies that participation in the CBM resulted in a reduction in production costs per kilogram of chicken produced. This could be the result of adoption of village poultry improvement technologies by the participants in CBM (cf. chapter 3).

Table 4.2. Village poultry production cost for participant and non-participant in CBM (FCFA/kg)

<table>
<thead>
<tr>
<th></th>
<th>Non-participant of non-experimental villages (n=57)</th>
<th>Non-participant of experimental villages (n=101)</th>
<th>Participant (144)</th>
<th>Total (302)</th>
<th>F stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>251.4 (215.2)</td>
<td>263.1 (281.2)</td>
<td>184.8 (179.4)</td>
<td>223.6 (227.1)</td>
<td>4.14**</td>
</tr>
<tr>
<td>Feed cost</td>
<td>51.4 (50.6)</td>
<td>43.4 (33.6)</td>
<td>58.2 (73.3)</td>
<td>52.0 (58.7)</td>
<td>1.89</td>
</tr>
<tr>
<td>Veterinary cost</td>
<td>34.4 (40.8)</td>
<td>23.8 (26.6)</td>
<td>32.5 (30.2)</td>
<td>30.0 (31.6)</td>
<td>3.00*</td>
</tr>
<tr>
<td>Capital</td>
<td>148.3 (136.0)</td>
<td>145.5 (131.8)</td>
<td>147.7 (133.6)</td>
<td>147.1 (133.0)</td>
<td>0.01</td>
</tr>
<tr>
<td>Production cost</td>
<td>485.5 (303.7)</td>
<td>475.8 (351.5)</td>
<td>423.2 (296.1)</td>
<td>452.7 (317.3)</td>
<td>1.20</td>
</tr>
<tr>
<td>Production (kg/year)</td>
<td>46.6 (34.8)</td>
<td>66.8 (55.2)</td>
<td>75.7 (61.1)</td>
<td>67.3 (55.9)</td>
<td>5.75***</td>
</tr>
</tbody>
</table>

(1) F statistic for the test of equality of mean values (one-way analysis of variance).
( ): Figures in parenthesis are standard deviation;

The production cost structure indicates that, on average, labor constitutes the greatest share of the total production costs, with roughly 42% (table 4.3). Labor costs represent the largest share in the total production cost for non-participants of experimental villages (about 46% of the total production costs) and non-participants of non-experimental village (48%). For participants in CBM, labor costs and the capital have almost the same share in the total production costs, roughly 38%. The depreciation or capital (with 35% to 38%) represents the second largest share in the total production costs for non-participants in CBM. The share for feeding costs comes in at the third place, with roughly 16% for participants in CBM and about 10% for non-participants in CBM.

These results, especially the share of feeding costs in the total production costs, are rather different from those observed in modern poultry production in Benin. Indeed, PADAP (2003) and Sodjinou et al. (2007) showed that feeding costs are the most important share in modern poultry: between 74% and 87% for egg production, and 42% for broilers.

Finally, the share of veterinary costs is slightly higher and the share of feeding costs is considerably higher (almost 60%) for participants in CBM than for non-participants. This may be due to the fact that they have adopted more poultry improvement technologies than non-participants, as we showed in chapter 3.
Table 4.3. Poultry production cost structure for participant and non-participant in CBM

<table>
<thead>
<tr>
<th></th>
<th>Non-participant of non-experimental villages</th>
<th>Non-participant of experimental villages</th>
<th>Participant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>48.1</td>
<td>45.9</td>
<td>38.0</td>
<td>42.2</td>
</tr>
<tr>
<td>Feeding cost</td>
<td>9.6</td>
<td>10.2</td>
<td>15.7</td>
<td>12.9</td>
</tr>
<tr>
<td>Veterinary cost</td>
<td>7.3</td>
<td>5.7</td>
<td>8.8</td>
<td>7.5</td>
</tr>
<tr>
<td>Capital</td>
<td>35.0</td>
<td>38.2</td>
<td>37.6</td>
<td>37.4</td>
</tr>
</tbody>
</table>

Figures in this table are % of total production costs

4.3.2. Profitability of village poultry farming

The annual revenue from poultry production is higher for participants in CBM (FCFA 66,968) than it is for non-participants of experimental (FCFA 56,207) and non-experimental (FCFA 40,777) villages (table 4.4). In the same way, the annual return over variable costs is higher for participants in CBM (FCFA 61,017) than for non-participants of experimental (FCFA 52,641) and non-experimental (FCFA 37,660) villages. A one-way analysis of variance (ANOVA) indicates a significant difference in average revenue from poultry rearing at 1% level. The comparison between the revenues of participants and non-participants of experimental villages (with t test, but not presented in table 4.4) did not show a significant difference at 10% level. On the other hand, the return over variable costs in experimental villages is significantly higher (at 5% level) than the value obtained in non-experimental villages.

The annual profit from poultry rearing is higher for participants (FCFA 42,595) than for non-participants of experimental (FCFA 33,733) and non-experimental villages (FCFA 22,345). The analysis of the variable carried out in order to compare these mean values indicates almost the same trend as that obtained for the return over variable costs. Besides, there is no significant difference between the average annual profit of participants and non-participants of experimental villages (at 10% level). But, there is a significant difference (at 5% level) between the average annual profit of producers of experimental and non-experimental villages.

The profit per kilogram of chicken produced did not show a significant difference between participants and non-participants in CBM. These profits are rather similar to those obtained in modern poultry farming in Benin (cf. Sodjinou et al., 2007). Indeed, these authors found FCFA 479 per kilogram for broilers in South Benin.

The average productivity per parent animal is higher for participants (FCFA 11,516 per parent per year) than the non-participants of experimental (FCFA 9,114) and non-experimental villages (FCFA 8,977). A one-way ANOVA indicates a significant difference in average productivity of parent animals (at 1% level).

The average productivity of labor and vets show almost the same trend as the average productivity per parent animal. Put another way, the average productivity of labor and vets are
significantly (at 5% level) higher for participants in CBM than for non-participants of experimental and non-experimental villages. Finally, there is no significant difference regarding the average productivity of capital and feed between participants and non-participants in CBM.

In short, the profits from village poultry are greater for participants in the CBM than for non-participants. Similarly, the average productivity of parent animals, labor and vets is higher for participants in CBM than for non-participants. Also, non-participants of experimental villages have higher profits from poultry production than non-participants of non-experimental villages.

Table 4.4. Profitability of poultry production for participant and non-participant in CBM

<table>
<thead>
<tr>
<th></th>
<th>Non-participant of Non-experimental villages (n=57)</th>
<th>Non-participant of experimental villages (n=101)</th>
<th>Participant (n=144)</th>
<th>Total (n=302)</th>
<th>F-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (FCFA/year)</td>
<td>40776.5 (28006.4)</td>
<td>56206.9 (45712.1)</td>
<td>66967.6 (51571.0)</td>
<td>58425.4 (46895.7)</td>
<td>6.79***</td>
</tr>
<tr>
<td>Return over variable costs (FCFA/year)</td>
<td>37660.2 (26702.1)</td>
<td>52640.6 (43907.4)</td>
<td>61016.7 (47953.9)</td>
<td>53807.1 (44049.1)</td>
<td>5.99***</td>
</tr>
<tr>
<td>Return over variable costs (FCFA/kg)</td>
<td>853.4 (251.6)</td>
<td>815.0 (288.2)</td>
<td>835.4 (288.9)</td>
<td>831.9 (281.5)</td>
<td>0.36</td>
</tr>
<tr>
<td>Profit (FCFA/year)</td>
<td>22345.0 (22866.0)</td>
<td>33733.3 (40898.7)</td>
<td>42595.0 (41894.5)</td>
<td>35809.3 (39301.8)</td>
<td>5.81***</td>
</tr>
<tr>
<td>Profit (FCFA/kg)</td>
<td>453.7 (295.1)</td>
<td>406.4 (405.0)</td>
<td>502.9 (342.9)</td>
<td>461.3 (358.3)</td>
<td>2.19</td>
</tr>
</tbody>
</table>

Average productivity of:

- Parent (FCFA): 8976.5 (4626.6) vs 9113.7 (5748.6) vs 11516.1 (7870.8) vs 10233.4 (6774.9) with a F-stat of 5.08***
- Labour (FCFA/manday): 4166.8 (5611.9) vs 5260.0 (6969.6) vs 6592.8 (7750.3) vs 5689.2 (7171.1) with a F-stat of 2.64*
- Vet (FCFA/FCFA): 60.6 (68.4) vs 156.9 (282.6) vs 81.6 (162.5) vs 102.8 (203.7) with a F-stat of 5.74***
- Capital (FCFA/FCFA): 13.5 (12.3) vs 11.8 (10.2) vs 11.9 (12.0) vs 12.2 (11.5) with a F-stat of 0.48
- Feed (FCFA/FCFA): 32.1 (22.5) vs 44.3 (49.3) vs 40.6 (46.8) vs 40.2 (44.3) with a F-stat of 1.40

(): Figures in parenthesis are standard deviation;
*** Significant at 1%, ** Significant at 5%, * Significant at 10%

4.3.3. Gender differences in poultry profitability

For the participants in CBM, the annual production is higher for men (85 kg per year) than for women (66 kg per year) and the difference is statistically significant at 10% level (table 4.5). The same tendency is noted among non-participants, with an annual production of 68 kg for men compared to 46 kg for women, with the difference being statistically significant at 5% level (table 4.6). In both cases, the difference between men and women can be explained by the fact that men usually have access to more labor and capital than women, as noted in chapter 3.

For participants in CBM, the annual return over variable costs and the annual profit for men is not statistically different (at 5%) from those of women. For non-participants, the annual return
over variable costs and the annual profit for men and women is not statistically different (at 5%). However, for non-participants in CBM, the revenue of men (FCFA 55,027) is higher than that of women (FCFA 43,280) and statistically significant at 10% level.

The return over variable costs per kilogram of chicken produced is higher for women participating in CBM (about FCFA 886 per kg) than for men (about FCFA 785 per kg). The same trend is noted amongst non-participants in CBM, with FCFA 877 per kg for women compared to FCFA 800 per kg for men. These results imply that, despite the low access to labor and financial means, women have a higher profit per kilogram of chicken produced than men in village poultry production.

Table 4.5. Profitability of village poultry production for male and female participants in CBM

<table>
<thead>
<tr>
<th></th>
<th>Female (n=72)</th>
<th>Male (n=72)</th>
<th>Total (n=144)</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output in kg of chicken equivalent</td>
<td>66.2 (57.5)</td>
<td>85.3 (63.4)</td>
<td>75.7 (61.1)</td>
<td>-1.90*</td>
</tr>
<tr>
<td>Revenue (FCFA/year)</td>
<td>64082.8 (57002.7)</td>
<td>69852.4 (45721.0)</td>
<td>66967.6 (51571.0)</td>
<td>-0.67</td>
</tr>
<tr>
<td>Return over variable costs (FCFA/year)</td>
<td>58824.0 (53019.3)</td>
<td>63209.5 (42552.8)</td>
<td>61016.7 (47953.9)</td>
<td>-0.55</td>
</tr>
<tr>
<td>Return over variable costs (FCFA/kg)</td>
<td>886.0 (312.4)</td>
<td>784.7 (255.6)</td>
<td>835.4 (288.9)</td>
<td>2.13**</td>
</tr>
<tr>
<td>Profit (FCFA/year)</td>
<td>42032.2 (45543.8)</td>
<td>43157.8 (38211.7)</td>
<td>42595.0 (41894.5)</td>
<td>-0.16</td>
</tr>
<tr>
<td>Profit (FCFA/kg)</td>
<td>526.5 (339.0)</td>
<td>479.3 (326.7)</td>
<td>502.9 (342.9)</td>
<td>0.82</td>
</tr>
<tr>
<td>Average productivity of:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent (Fcfa)</td>
<td>12196.2 (8353.5)</td>
<td>10836.1 (7352.0)</td>
<td>11516.1 (7870.8)</td>
<td>1.04</td>
</tr>
<tr>
<td>Labor (FCFA/man-day)</td>
<td>5870.0 (7278.9)</td>
<td>7315.6 (8181.5)</td>
<td>6592.8 (7750.3)</td>
<td>-1.12</td>
</tr>
<tr>
<td>Vet (FCFA/FCFA)</td>
<td>96.4 (195.5)</td>
<td>66.8 (120.5)</td>
<td>81.6 (162.5)</td>
<td>1.09</td>
</tr>
<tr>
<td>Capital (FCFA/FCFA)</td>
<td>12.3 (12.5)</td>
<td>11.5 (11.6)</td>
<td>11.9 (12.0)</td>
<td>0.41</td>
</tr>
<tr>
<td>Feed (FCFA/FCFA)</td>
<td>35.5 (41.0)</td>
<td>45.6 (51.7)</td>
<td>40.6 (46.8)</td>
<td>-1.30</td>
</tr>
</tbody>
</table>

( ): Figures in parenthesis are standard deviation; 
*** Significant at 1%, ** Significant at 5%, * Significant at 10%

For the participants in the CBM, women’s average productivity of parent animals is higher than that of men. In other words, women obtain revenue of FCFA 12,196 per parent compared to FCFA 10,836 for men. It follows that, on average, a woman would generate more revenue than a man if an additional parent animal is given to her.

Similarly, women’s average productivity for vets and capital is higher than men’s. However, regarding labor and feed; men have a higher average productivity than women. In all cases, the difference is not statistically significant at 5% level.

For non-participants in the CBM, men’s average productivity of parent animals is higher than that of women. The trend is the same for labor and feed. It is only in the case of vets that women, who do not participate in CBM, have a higher average productivity than men. Here also, the difference between men and women is not significant at 5% level.
4.4. Determinants of village poultry survival rate

The results of table 4.7 indicate that a henhouse has a positive and statistically significant effect (at 1% level) on the survival rate of chickens and chicks. More precisely, the utilization of a henhouse is more likely to increase the probability of a chicken’s survival rate by 10.5 percentage points. This result implies that building shelter for poultry is an important factor in increasing their survival rate. This is because a henhouse reduces deaths due to road accidents and predators such as snake, shrews, and rats. The policy implication of this is that the provision of housing for poultry is important for the development of traditional poultry farming as an income generating activity. However, henhouse construction requires money – not only for the construction, but also for the purchase of equipment such as troughs.

Having a chick-house negatively and significantly influences (at 1% level) the survival rate of chickens and chicks. This negative sign is in contrast to the expected positive sign. According to the interviewed producers, this can be explained by the fact that chicks are frequently killed by ants, shrews, and snakes (in particular during the night) when the small birds are sheltered without special care (e.g. use of carbide from weld to surround the shelter). According to the breeders surveyed, the mortality rate increases when chicks are fed directly in the chick-house, since the feed attracts ants. This can be explained by the fact that farmers tend not to clean the chick-house properly after feeding. Therefore, it is important that breeders either clean their chick-houses more frequently, especially after feeding, in order to avoid food scraps attracting predators, or feed their chicks outside the chick-house.
The use of improved feeding has a positive and significant effect (at 5% level) on the survival rate of chickens. The use of improved feed made with locally available products, diffused through the CBM, will probably increase the poultry survival rate by 5.6 percentage points. This result is consistent with the finding of Tung (2007), who showed that the feeding method (based on the use of concentrated feed in village poultry production in Vietnam) has a positive and significant effect on chickens’ survival rate. He explains this by the fact that the use of improved feed increases feed intake and hence improves birds’ resistance to diseases. Clarke (2004) claimed that supplementary feeding can greatly improve the poultry’s performance, but care must be taken to ensure that the feed provided is affordable and locally available. When supplementary feed is scarce, farmers should be encouraged to ensure that chicks up to the age of one month have access to additional feed, as young chicks are the first to suffer from food shortages (Clarke, 2004). The main implication of this finding is that, in the use of poultry as a tool for poverty reduction, the use of supplementary feed (i.e. the use of improved feed) should be emphasized in order to improve the birds’ survival rate and performance.

### Table 4.7. Estimated censored regression for factors influencing the survival rate of chicken and chicks

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
<th>Coefficient</th>
<th>t</th>
<th>Marginal effect</th>
<th>Coefficient</th>
<th>t</th>
<th>Marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHIKHUS</td>
<td>Have chick-house (1=yes, 0=no)</td>
<td>-0.119***</td>
<td>4.14</td>
<td>-0.111***</td>
<td>-0.112***</td>
<td>2.97</td>
<td>-0.100***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.029)</td>
<td></td>
<td>(0.027)</td>
<td>(0.038)</td>
<td></td>
<td>(0.034)</td>
</tr>
<tr>
<td>HENHUS</td>
<td>Have henhouse (1=yes, 0=no)</td>
<td>0.113***</td>
<td>4.06</td>
<td>0.105***</td>
<td>0.077**</td>
<td>2.12</td>
<td>0.068**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.028)</td>
<td></td>
<td>(0.026)</td>
<td>(0.036)</td>
<td></td>
<td>(0.032)</td>
</tr>
<tr>
<td>FEED</td>
<td>Make improved feed for chickens (1=yes, 0=no)</td>
<td>0.062**</td>
<td>2.04</td>
<td>0.056**</td>
<td>-0.032</td>
<td>-0.83</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.030)</td>
<td></td>
<td>(0.027)</td>
<td>(0.038)</td>
<td></td>
<td>(0.034)</td>
</tr>
<tr>
<td>VACCIN</td>
<td>Vaccination of poultry (1=yes, 0 otherwise)</td>
<td>0.061**</td>
<td>2.41</td>
<td>0.056**</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.025)</td>
<td></td>
<td>(0.023)</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>VETERC</td>
<td>Expenses in vet, medicines, etc. (10000 FCFA)</td>
<td>-0.015</td>
<td>-0.72</td>
<td>-0.014</td>
<td>0.045*</td>
<td>1.68</td>
<td>0.040*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.022)</td>
<td></td>
<td>(0.020)</td>
<td>(0.027)</td>
<td></td>
<td>(0.024)</td>
</tr>
<tr>
<td>DMARKET</td>
<td>Distance from household to the nearest market (100 km)</td>
<td>-0.639**</td>
<td>-2.34</td>
<td>-0.584**</td>
<td>-1.246***</td>
<td>-3.47</td>
<td>-1.105***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.272)</td>
<td></td>
<td>(0.249)</td>
<td>(0.359)</td>
<td></td>
<td>(0.318)</td>
</tr>
<tr>
<td>(Constant)</td>
<td></td>
<td>0.640***</td>
<td>23.19</td>
<td>NN</td>
<td>0.694***</td>
<td>20.21</td>
<td>NN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.028)</td>
<td></td>
<td>NN</td>
<td>(0.034)</td>
<td></td>
<td>NN</td>
</tr>
</tbody>
</table>

(1): Figures in parenthesis are standard errors. Threshold values for the models: lower = 0, upper = 1. NN: Not Need, Nd = Not determined

(1) The variable VACCIN (vaccination) was not included in chick model since breeders do not vaccinate chicks.

For chickens: N= 385, Likelihood Ratio chi-square (6) = 46.92***, Log likelihood = -4.155;
For chicks: N= 363, Likelihood Ratio chi-square (5) = 24.04***, Log likelihood = -113.987

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

Vaccination positively and significantly influences (at 5% level) the survival rate of chickens. The use of modern vaccination is likely to increase chicken’s survival rate by 5.6 percentage points. Therefore, targeting village poultry vaccination could be an important way to increase the survival rate of chickens. This result shows the role that vaccination plays in the improvement of village poultry performance. In several countries, in fact, interesting results have been obtained after good vaccination campaigns against poultry diseases. For instance, in Bangladesh, a
Newcastle Disease (ND) vaccination campaign reduced mortality from 41% to 19% in one year (Clarke, 2004). In Benin, the introduction of vaccination against ND and other management measures (through PADAV project) have resulted in a general decrease in the mortality rate of participating smallholders’ poultry flocks (Nielsen and Chrysostome, 2003b). However, most village poultry producers have poor access to veterinary and extension services, and hence are either unaware of the benefits of disease control, or unable to access the vaccines and drugs needed to protect their birds. When animal health services are unavailable and bird mortality is high, awareness and interest in improved husbandry practices does not generally exist (Kryger et al., 2010: 33).

It is worth noting that chicks are not vaccinated in the study area. Accordingly, these small birds remain at risk of being infected by Newcastle Disease. Indeed, since mainly adult chickens are vaccinated, the chicks (of the producers who vaccinated their poultry) are easily contaminated by non-vaccinated chickens. As stated by the interviewed breeders, this situation results from the fact that one part of the village dwellers vaccinate their chickens, whilst others do not. This situation is a direct consequence of the technique of traditional poultry farming (mainly scavenging) used by the producers. The scavenging method encourages permanent contact with non-vaccinated birds which carry the disease which the birds have been vaccinated against.

Furthermore, the farmers who live close to markets are more likely to have a high poultry survival rate (variable DMARKET has a negative and significant coefficient) than farmers living far away from markets. Living one kilometer away from a market would, ceteris paribus, lead to a 0.6 % decrease in the survival rate of chickens and 1.1 % for chicks. In other words, access to markets for inputs and veterinary services is important to improve the survival rate of poultry (chickens and chicks). This result is in accordance with the finding of Tung (2007), who states that access to veterinary services has a significant effect on poultry’s survival rate improvement.

In short, the most important factors to concentrate on to improve the survival rate of village poultry, in decreasing order, are henhouse construction, improved feed and vaccination. As Kryger et al. (2010: 34) stated, there is no doubt that vaccination of village poultry against Newcastle Disease and the provision of other animal health services can improve the productivity of village poultry. Kryger et al. (2010: 34) further notes that in rural areas where these types of services have been provided and awareness of the animal health services raised, village poultry producers, even the poor, show willingness and ability to pay for these services.
**4.5. Technical efficiency and marginal productivity in village poultry production**

**4.5.1. Technical efficiency**

The results of the maximum likelihood estimates of the stochastic production frontier model are presented in table 4.8. The partial production elasticities calculated at the mean input quantities are also presented in this table. The analysis of these elasticities indicates that an increase in the capital by 10% will lead to a 3.1% increase in village poultry output. In the same way, a 10% increase in labor will lead to approximately 0.3% increase in poultry output. Furthermore, a 10% increase in veterinary services and feed is likely to increase poultry output by 1.4% and 1% respectively. The calculated elasticity of scale is less than unity (i.e., 0.58), which indicates that sample breeders actually operate under decreasing returns to scale. These results are in line with the findings of other studies (e.g. Akter et al., 2003; Oladeebo and Ambe-Lamidi, 2007) carried out in village poultry farming. Indeed, using a Cobb Douglas production function, Akter et al. (2003) found that the elasticity of scale in poultry production in Vietnam was significantly less than unity (0.68 in the North and 0.876 in the South). In Osun State (Nigeria), Oladeebo and Ambe-Lamidi (2007) found that there are decreasing returns to scale (elasticity of scale was 0.76) in poultry production.

The lower panel of table 4.8 presents the estimates of the inefficiency model. The standard errors must be interpreted with caution as they might be downward biased (Henningsen and Henning, 2009). The average technical efficiency index is 89%, which indicates that an inefficiency effect amongst village poultry breeders exists; i.e. there is room to increase village poultry output in Benin. Table 4.8 indicates that farmers who received formal education are, on average, 14 percentage points more efficient in village poultry production than non-educated farmers. In the same way, breeders in the experimental village are significantly more efficient in village poultry production than those from non-experimental villages (on average 21 percentage points). Also, men are, on average, 10 percentage points more efficient than women.

Participation in community-based management (CBM) does not have a significant effect on farmers’ efficiency in village poultry production. However, the negative sign of this variable indicates that breeders who participate in CBM are more efficient than breeders who do not participate in CBM (on average only 3 percentage points). Also, there is no significant difference between breeders who received credit and those who did not receive credit.

Furthermore, distance to market has a negative and significant sign (at 1% level); meaning that peasants who are closer to a market are less efficient than those who are situated far from a market. In other words, access to market for inputs and output seems to decrease peasants’ efficiency in village poultry production. One kilometer farther away from the market would result in a 3 percentage points increase in breeders’ efficiency.
Table 4.8. Estimates of the Stochastic Production Frontier Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Label</th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>z-stat</th>
<th>Coefficients</th>
<th>Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LnLABOUR</td>
<td>Ln (labor)</td>
<td>-0.055</td>
<td>0.383</td>
<td>-0.14</td>
<td>0.004</td>
<td>0.030</td>
</tr>
<tr>
<td>LnCAPITAL</td>
<td>Ln (capital)</td>
<td>0.596</td>
<td>0.366</td>
<td>1.63</td>
<td>0.210</td>
<td>0.309</td>
</tr>
<tr>
<td>LnVET</td>
<td>Ln (veterinary cost)</td>
<td>-0.077</td>
<td>0.339</td>
<td>-0.23</td>
<td>-0.056</td>
<td>0.143</td>
</tr>
<tr>
<td>LnFEED</td>
<td>Ln (feed cost)</td>
<td>-0.708*</td>
<td>0.407</td>
<td>-1.74</td>
<td>-0.165</td>
<td>0.101</td>
</tr>
<tr>
<td>LnLAB2</td>
<td>Ln (labor)²</td>
<td>0.080</td>
<td>0.075</td>
<td>1.07</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>LnCAP2</td>
<td>Ln (capital)²</td>
<td>0.047</td>
<td>0.072</td>
<td>0.65</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>LnVET2</td>
<td>Ln (veterinary cost)²</td>
<td>0.129***</td>
<td>0.040</td>
<td>3.25</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td>LnFEED2</td>
<td>Ln (feed cost)²</td>
<td>0.199***</td>
<td>0.060</td>
<td>3.31</td>
<td>0.043</td>
<td></td>
</tr>
<tr>
<td>LnLABCAP</td>
<td>Ln (labor) x Ln (capital)</td>
<td>-0.021</td>
<td>0.052</td>
<td>-0.41</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>LnLABVET</td>
<td>Ln (labor) x Ln (veterinary cost)</td>
<td>-0.017</td>
<td>0.043</td>
<td>-0.41</td>
<td>-0.009</td>
<td></td>
</tr>
<tr>
<td>LnLABFEED</td>
<td>Ln (labor) x Ln (feed cost)</td>
<td>0.024</td>
<td>0.058</td>
<td>0.42</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>LnCAPVET</td>
<td>Ln (capital) x Ln (veterinary cost)</td>
<td>-0.029</td>
<td>0.039</td>
<td>-0.76</td>
<td>-0.006</td>
<td></td>
</tr>
<tr>
<td>LnCAPFEED</td>
<td>Ln (capital) x Ln (feed cost)</td>
<td>-0.057</td>
<td>0.055</td>
<td>-1.04</td>
<td>-0.008</td>
<td></td>
</tr>
<tr>
<td>LnVETFEED</td>
<td>Ln (veterinary cost) x Ln (feed cost)</td>
<td>-0.044</td>
<td>0.038</td>
<td>-1.17</td>
<td>-0.001</td>
<td></td>
</tr>
<tr>
<td>(constant)</td>
<td></td>
<td>2.098*</td>
<td>1.101</td>
<td>1.91</td>
<td>1.677</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inefficiency factors obtained after imposing monotonicity condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENDER</td>
<td>Gender of the breeder (1 = male)</td>
<td>-0.281**</td>
<td>0.115</td>
<td>-2.44</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the breeder (year)</td>
<td>-0.015</td>
<td>0.017</td>
<td>-0.85</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>AGE2</td>
<td>Squared of [AGE]</td>
<td>0.0001</td>
<td>0.0002</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDUC</td>
<td>Formal education (1 = yes)</td>
<td>-0.388**</td>
<td>0.187</td>
<td>-2.08</td>
<td>0.138</td>
<td></td>
</tr>
<tr>
<td>CREDIT</td>
<td>Access to poultry-based credit (1 = yes)</td>
<td>0.294</td>
<td>0.244</td>
<td>1.20</td>
<td>-0.105</td>
<td></td>
</tr>
<tr>
<td>EXPVILL</td>
<td>Experimental village (1 = yes)</td>
<td>-0.580***</td>
<td>0.200</td>
<td>-2.91</td>
<td>0.207</td>
<td></td>
</tr>
<tr>
<td>CBM</td>
<td>Participation in community-based management (1 = yes)</td>
<td>-0.085</td>
<td>0.240</td>
<td>-0.35</td>
<td>0.030</td>
<td></td>
</tr>
<tr>
<td>MARKET</td>
<td>Distance to the nearest market (km)</td>
<td>-0.089***</td>
<td>0.022</td>
<td>-4.06</td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>(constant)</td>
<td></td>
<td>1.531***</td>
<td>0.460</td>
<td>3.33</td>
<td>NN</td>
<td></td>
</tr>
</tbody>
</table>

N = 302; Wald chi-square Stat. (14) = 220.81***; Log likelihood = -254.09; σ² = 0.329***; Elasticity of scale = 0.583; MGF = Mean values of the marginal effects (mean values over all observations); NN = Not Need
*** Significant at 1%, ** Significant at 5%, * Significant at 10%

4.5.2. Marginal products according to the participation in community-based management

Table 4.9 shows that there is significant difference (at 10% level) between participants and non-participants in terms of the marginal product of labor. In other words, the marginal product of labor is higher for participants in CBM (144 FCFA/man-day) than for non-participants of experimental (129 FCFA/man-day) and non-experimental (91 FCFA/man-day) villages. For the other inputs, there is no significant difference between participants and non-participants in CBM.
The marginal product of labor (about FCFA 129 per man-day, see table 4.9) is lower than the average price paid for labor in the research villages, i.e. FCFA 520 per man-day. This suggests that farmers would earn more by selling their labor than using it in poultry production. Based on this, one can say that it would be advisable to increase capital input, expenses for vet, and feed. Clearly, an increase in expenses for vet by FCFA 100, *ceteris paribus*, would improve the producer's revenue by FCFA 830. The increase of capital and expenses in feed by FCFA 100 would increase producer’s revenue by FCFA 360 and FCFA 300, respectively. Therefore, overall, an increase in expenses in vet treatment (especially expenses in village poultry vaccination) is the main option for the improvement of poultry breeders’ revenue. This confirms one of the conclusions of section 4.4, which states that vaccination plays an important role in the improvement of village poultry performance.

Table 4.9. Marginal products according to breeders’ participation in CBM

<table>
<thead>
<tr>
<th>Marginal product of</th>
<th>Non-participant of Non-experimental villages (n=57)</th>
<th>Non-participant of experimental villages (n=101)</th>
<th>Participant (n=144)</th>
<th>Total (n=302)</th>
<th>F-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vet (FCFA/FCFA)</td>
<td>6.7 (4.2)</td>
<td>8.9 (8.2)</td>
<td>8.5 (9.1)</td>
<td>8.3 (8.1)</td>
<td>1.50</td>
</tr>
<tr>
<td>Labor (FCFA/man-day)</td>
<td>91.4 (88.0)</td>
<td>129.1 (142.0)</td>
<td>143.8 (159.0)</td>
<td>129.0 (143.3)</td>
<td>2.76*</td>
</tr>
<tr>
<td>Capital (FCFA/FCFA)</td>
<td>3.9 (3.3)</td>
<td>3.5 (2.9)</td>
<td>3.5 (3.3)</td>
<td>3.6 (3.2)</td>
<td>0.28</td>
</tr>
<tr>
<td>Feed (FCFA/FCFA)</td>
<td>2.5 (1.5)</td>
<td>3.1 (2.6)</td>
<td>3.0 (2.2)</td>
<td>3.0 (2.3)</td>
<td>1.27</td>
</tr>
</tbody>
</table>

4.5.3. Gender difference in marginal products

For participants in the CBM, table 4.10 shows that women have a marginal product of vet (9.3 FCFA / FCFA) higher than men (7.7 FCFA / FCFA). It follows that women would gain FCFA 9.3, *ceteris paribus*, per one FCFA increase in veterinary expenses, compared to FCFA 7.7 for men. Regarding capital and labor, women have a higher marginal product than men. Thus, increasing labor use by one man-day would, *ceteris paribus*, increase women's production by FCFA 147 compared to FCFA 141 for men. In other words, if women increase labor use, they would increase their poultry production faster than men. For capital, women have a slightly higher marginal product than men. On the other hand, for the feed, men have a higher marginal product than women. In all cases, however, the difference between men and women is not significant at 5% level. But, from the above results, we can say that women have a marginal product which is almost equivalent to that of men, and in some cases (e.g. vet and labor) the marginal product is higher for women than for men.

Concerning non-participants in CBM, table 4.11 indicates that women and men have almost the same marginal products with regard to the vet, capital, and feed. For labor, men have a relatively higher marginal product than women. However, the difference is not significant at 5% level.
In short, we can say that, for the participants in CBM, although they have less access to credit and labor, women have a marginal product which is almost equivalent to that of men, and in some cases (e.g. vet and labor) these marginal products are actually higher for women than for men. On the other hand, for non-participants in CBM, men have a marginal product of labor which is higher than that of women. For other factors of production, men and women non-participants in CBM have almost the same marginal product.

As illustrated in Section 4.5.2, an increase in veterinary expenses is the most reasonable option for improving the breeders’ revenue from village poultry production. But here, for the participants in CBM, an increase in expenses in vet would be more effective for women than for men. In fact, an increase in the expenses in vet by FCFA 100 would, ceteris paribus, lead to an increase of FCFA 930 for women compared to FCFA 770 for men. The main implication of this result is that women would perform better if they had more money to finance the vaccination of their birds.

### Table 4.10. Marginal products for female and male participant in CBM

<table>
<thead>
<tr>
<th>Marginal product of</th>
<th>Female (n=59)</th>
<th>Male (n=99)</th>
<th>Total (n=158)</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vet (FCFA/FCFA)</td>
<td>9.3 (10.1)</td>
<td>7.7 (8.0)</td>
<td>8.5 (9.1)</td>
<td>1.07</td>
</tr>
<tr>
<td>Labor (FCFA/man-day)</td>
<td>147.0 (177.1)</td>
<td>140.6 (139.8)</td>
<td>143.8 (159.0)</td>
<td>0.24</td>
</tr>
<tr>
<td>Capital (FCFA/FCFA)</td>
<td>3.6 (3.3)</td>
<td>3.4 (3.3)</td>
<td>3.5 (3.3)</td>
<td>0.35</td>
</tr>
<tr>
<td>Feed (FCFA/FCFA)</td>
<td>2.9 (2.4)</td>
<td>3.1 (2.1)</td>
<td>3.0 (2.2)</td>
<td>-0.51</td>
</tr>
</tbody>
</table>

### Table 4.11. Marginal products for female and male participant in CBM

<table>
<thead>
<tr>
<th>Marginal product of</th>
<th>Female (n=59)</th>
<th>Male (n=99)</th>
<th>Total (n=158)</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vet (FCFA/FCFA)</td>
<td>8.1 (6.8)</td>
<td>8.1 (7.3)</td>
<td>8.1 (7.1)</td>
<td>-0.07</td>
</tr>
<tr>
<td>Labor (FCFA/man-day)</td>
<td>110.6 (137.2)</td>
<td>118.4 (119.9)</td>
<td>115.5 (126.3)</td>
<td>-0.37</td>
</tr>
<tr>
<td>Capital (FCFA/FCFA)</td>
<td>3.6 (3.0)</td>
<td>3.7 (3.1)</td>
<td>3.7 (3.0)</td>
<td>-0.07</td>
</tr>
<tr>
<td>Feed (FCFA/FCFA)</td>
<td>2.8 (2.0)</td>
<td>3.0 (2.4)</td>
<td>2.9 (2.3)</td>
<td>-0.52</td>
</tr>
</tbody>
</table>

### 4.6. Conclusion and implications

Village poultry is profitable for participants as well as for non-participants in community-based management (CBM). The annual revenues from village poultry are greater for participants in the CBM than for non-participants. Similarly, the average productivity of parent animals, labor and vet are higher for participants in CBM than for non-participants. Also, non-participants of experimental villages have higher profit from poultry production than non-participants of non-experimental villages.

The return over variable costs per kilogram of chicken produced is higher for women who participate in CBM than for men. The same trend is noted amongst non-participants in CBM:
female producer have higher returns over variable costs than their male counterparts. These results imply that, despite the low access to labor and financial means, women attain a higher profit per kilogram of chicken produced than men in village poultry production. Also, for the participants in CBM, the average productivity of parent animals is higher for women than it is for men, which indicates that, on average, women would generate greater annual revenue than men when given an additional parent bird. In the same way, for the participants in CBM, women have a marginal product which is almost equivalent to that of men, and in some cases (e.g. vet and labor) the marginal product is actually higher for women than it is for men.

The main factors which influence the village poultry survival rate are, in decreasing order, henhouses, improved feed, and vaccination. In other words, the construction of henhouses is the most important factor if one wants to develop traditional poultry farming. Once birds are sheltered, the feeding and vaccination should follow. Also, there is no doubt that vaccination against Newcastle Disease and other animal health services can improve the productivity of village poultry.

Finally, an inefficiency effect exists amongst village poultry breeders, which means that there is room to increase village poultry output, given existing technology. Educated farmers and those living far from markets seem to be more efficient in village poultry production than non-educated farmers and those living near markets. Also, community-based management has a positive effect on breeders’ efficiency not only for participants in CBM, but also for non-participants of experimental villages.
Chapter 5.
Impact of poultry-based interventions on rural households’ living conditions

5.1. Introduction

As stated in chapter one, Benin is among the poorest countries in the world with an agriculture-based economy. Poverty is more prevalent in rural areas where many people (84% of farm households) depend on village poultry for their livelihood. Recognizing this role, the government of Benin and various development agencies have supported village poultry development as a tool for poverty alleviation and gender empowerment. The projects implemented for this purpose have had two components: a technical part (community-based management of village poultry) and a financial part (microfinance).

The motivation of this chapter is to assess the impact of these poultry-based interventions on rural households’ living conditions. More clearly, the purpose of this chapter is to evaluate the impact of each component (community-based management and microfinance) considered individually and in combination. The main difficulties in assessing this impact are: (i) how to separate the effect of CBM from the effect of microfinance, (ii) how to separate the effects of these interventions from those of other interventions and socioeconomic factors that simultaneously affect households’ living conditions.

The first issue (i) is tackled by separating the target population into five groups. The first group constituted households that had participated in community-based management (CBM) and in a poultry-based microfinance program (PBM, i.e. microfinance granted for poultry production). The second group was composed of households that had participated in CBM and in a non-poultry-based microfinance program (NPBM, i.e. a microfinance program which was not formally granted for poultry production). The third group was composed of households that had participated in CBM, but had not received microfinance. The fourth group constituted households that had not participated in CBM, but had participated in NPBM. The last group constituted households that had not participated in CBM or in microfinance programs. In short, the sample of table 2.4 (cf. chapter 2) was divided into five subsamples (figure 5.1). It is worth noting that, in the sample, there were five households that participated simultaneously in CBM, PBM and NPBM. These five households are not included in the analysis carried out in this chapter.

As stated in chapter one, participation in the CBM was free. The participants in CBM were free to participate in PBM or NPBM, or they could not participate in any microfinance program. The non-participants in CBM were free to participate in NPBM or to not participate in any
microfinance program. These are multiple treatments where participation in any of the five treatments (defined above) was not randomly assigned. Indeed, there was self-selection into treatment, i.e. households (partly) determine whether they participate in a given treatment and their decision may be related to the benefits derived from this treatment. In this situation, Propensity Score Matching (PSM) can be used to control for selection that normally arises when assignment into treatment is not random. So, the second issue (ii) was tackled using the PSM.

The remainder of the chapter is organized as follows. Section 5.2, describes the theoretical framework, discusses the impact assessment problem, and details the matching methods for estimation of the treatment effects. Section 5.3 deals with the empirical framework and describes the outcome variables, as well as an assessment of the quality of the propensity score matching. In section 5.4, we describe the surveyed households and the items which surveyed households spend the money from poultry production on. In section 5.5, we analyze and discuss the results of the PSM for the assessment of the impact of poultry-based interventions on household’s living conditions. The chapter ends with section 5.6 which presents some conclusions and implications.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Participation in Community-Based Management (CBM)</th>
<th>Participation in Microfinance Program</th>
<th>Type of treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveyed households (n=303)</td>
<td>CBM (CBM)</td>
<td>Poultry-Based Microfinance (PBM)</td>
<td>CBM * PBM (n1 = 103)</td>
</tr>
<tr>
<td></td>
<td>Non CBM (NCBM)</td>
<td>Non Poultry-Based Microfinance (NPBM)</td>
<td>CBM * NPBM (n2 = 14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No Microfinance (NM)</td>
<td>CBM * NM (n2 = 25)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non Poultry-Based Microfinance (NPBM)</td>
<td>NCBM*NPBM (n1 = 46)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No Microfinance (NM)</td>
<td>NCBM*NM (n3 = 110)</td>
</tr>
</tbody>
</table>

Figure 5.1. Distribution of the surveyed households according to the treatment received
5.2. Theoretical framework

5.2.1. Impact assessment problem and parameters of interest

- The impact assessment problem

Let $i$ be a given household and $t = 0, \ldots, k$ denote the treatments. Suppose that $d_i \in \{0, 1\}$ denotes the treatment indicators for each of the $t$ treatments, where $d_i = 1$ if a household receives treatment $t$ and $d_i = 0$ otherwise. It is assumed that each household receives exactly one of the treatments $t$. To be in agreement with our empirical work, let treatment $t = 0$ as no treatment, i.e. the baseline.

Now, suppose that one wants to determine the effect of $d_i$ on some outcome variable, e.g. households’ income, $y$. The challenge in treatment effect evaluation is to demonstrate that variation in $y$ can be unambiguously attributed to $d_i$. To explain this better, let $y_t$ be the level of income of a household that is in program $t \neq 0$ and $y_0$ the same household’s income when it receives no treatment ($t = 0$). For this household, the observed response is:

$$y = d_i y_t + (1 - d_i) y_0 \quad (5.1)$$

Since one cannot observe $y_{It}$ and $y_0$ for the same household, the impact of the treatment $t$ on a household is never directly observed. In other words, we would not observe the income of the participant household if it had not participated. Also, it is almost impossible to say what the level of income of a non-participant household would be if it had participated, as a household is either in the program under consideration or not, but not both at the same time. One refers to this problem as the potential outcomes, counterfactual framework (Rosenbaum and Rubin, 1983; Wooldridge, 2002) or Roy–Rubin model (Caliendo and Kopeinig, 2008). Thus, the construction of this counterfactual is the central issue for impact evaluation methods.

It is worth noting that counterfactual framework explicitly allows for heterogeneity, not only in program impacts, but also in untreated outcomes (Cobb-Clark and Crossley, 2003). But, it is also restrictive in some ways. In particular, this model makes the so-called stable-unit-treatment-value assumption (SUTVA), which means that the treatment of unit $i$ only affects the outcome of unit $i$ (Wooldridge, 2002; Cobb-Clark and Crossley, 2003).

- Measure of treatment effects: what do we want to estimate?

In general, the most common measure of the treatment effect is the so called Average Treatment Effect on Treated (ATET), i.e. the average impact of treatment $t$ on the participants. This is given by:

\[ y = d_i y_t + (1 - d_i) y_0 \]

\[ (5.1) \]

In the impact evaluation literature, a household that is in the program is called treated, participant, recipient or beneficiary household. A household that is not in the program is the control, non-participant, non-recipient or non-beneficiary household.
where $E(.)$ denotes expectation in the population. The measure $\text{ATET}_t$ answers the following question (Heckman, 1997): how does a given treatment $t$ change the outcome of participants compared to what they would have experienced if they had not participated in this treatment $t$? Put differently, $\text{ATET}_t$ indicates the mean effect of receiving treatment $t$ relative to receiving no treatment for those households who receive treatment $t$.

Other measures of the treatment effect are the effect of the treatment on the untreated ($\text{ATEU}$) and the local average treatment effect ($\text{LATE}$).\textsuperscript{33} $\text{ATEU}$ can be meaningful in a situation where the expansion of a program is under consideration. $\text{LATE}$ measures the effect of the program on the households whose participation status changes due to a change in policy. In a multiple treatments context, Lechner (2000) and Imbens (2000) also described various other parameters, e.g. the mean effect of receiving treatment $t$ relative to treatment $s = 0,...,k$ for households who receive treatment $t$ and the mean effect of treatment $t$ on households who receive treatment $t$ or treatment $s$. We did not analyze these types of combinations in this study due to the nature of our data.

The main measure targeted in this study is the Average Treatment Effect on Treated ($\text{ATET}_t$). Various methods are available in the literature for the estimation of this measure. These methods can be broadly grouped into two categories (Wooldridge, 2002). The first category is based on assumptions concerning the \textit{ignorability} of the treatment conditional on a set of covariates. Regression, difference-in-difference and matching methods are in this category. A second category of estimators (e.g. Instrumental Variable methods) relies on the availability of one or more instrumental variables, which are redundant in the response equations, but help determine participation (Wooldridge, 2002).

According to Imbens (2004), regression estimators can be very sensitive to differences in the covariate distributions for treated and untreated units. Moreover, when the dimension of covariates $x$ is large, it may be difficult to include all covariates in the regression. The difference-in-difference approach is mainly informative for estimating the impact of a single program versus the non-participation program, but is of no help for comparisons between the programs (Frölich, 2004). Frölich (2004) argues that, instrumental variables are not suited for multiple programs impact evaluation. For instance, if as in our case, the policy consists of several different treatments, a single instrument would not suffice to estimate the various conceivable effects between the programs.

The choice of PSM in this study was also justified by the fact that various methods (e.g. difference-in-difference or instrumental variable) useful for the evaluation of a single program are less instructive for the evaluation of multiple treatments.

\textsuperscript{33} Discussion on these measures of treatment effects can be found in Heckman et al. (1999) and Todd (2008).
5.2.2. Matching methods: selection of the balancing score

In the literature on impact assessment, matching usually refers to methods aimed at identifying for each treated individual, one or more similar individuals (in term of covariates \( x \)) in the control group. It was initially suggested for the binary treatment (i.e. \( t = 0,1 \)) by Rosenbaum and Rubin (1983), and was later generalized by Imbens (2000) and Lechner (2000) for the case of multiple programs. In both cases (i.e. binary and multiple treatments), the implementation of matching methods consists of three main steps: selection of the matching method (the balancing score), selection of the matching algorithms, and analysis of the consistency of estimations (figure 5.2). The main difference between binary and multiple treatments is related to the choice of the balancing score.

**Figure 5.2. Matching implementing steps**

NN: Nearest Neighbor
Balancing score for binary treatment

Suppose that we have a single program $t = 0, 1$; implying that $d_t \subseteq \{0, 1\}$. In this section, we omit the $t$ subscript when it is not needed in order to reduce notational burden.

Matching is based on a so called balancing score, $b(x)$, which is a function of the vector of observed covariates $x$ such that the conditional distribution of $x$ given $b(x)$ is the same for treated ($d = 1$) and control ($d = 0$) units; that is (Rosenbaum and Rubin, 1983):

$$x \perp d \mid b(x),$$

where “$\perp$” denotes independence. Rosenbaum and Rubin (1983) showed that it is sufficient to match exactly on any balancing score $b(x)$ to obtain the same probability distributions of $x$ for treated and untreated group units in matched samples.

The two main balancing scores often used in the impact evaluation literature are Mahalanobis distance and propensity score. A simulation study carried out by Gu and Rosenbaum (1993) shows that if there are many covariates (say $k = 20$ covariates) and if the objective is to increase the balance in $x$, then matching using the propensity metric is much better at producing balanced matched samples than matching using the Mahalanobis distance. For $k = 2$ covariates, they state that the methods are similar with no consistent winner. In the impact evaluation literature, the matching based on the propensity score is termed propensity score matching.

The propensity score is the conditional probability of assignment to a particular treatment given the observed covariate $x$. It is given by:

$$p(x) = \Pr\{d = 1 \mid x\} = E(d \mid x)$$

(Rosenbaum and Rubin, 1983) argue that if the exposure to treatment is random within cells defined by $x$, it is also random within cells defined by the values of the mono-dimensional variable $p(x)$. The key assumption required is the strong ignorability, which has two parts: unconfoundedness and overlap. The unconfoundedness, exogeneity or conditional independence assumption (CIA)$^{34}$ states that, conditional on observed pre-treatment covariates $x$, the treatment assignment is independent of potential outcomes$^{35}$. It also implies that systematic differences in outcomes between treated and untreated individuals with the same values for covariate are due to treatment (Caliendo and Kopeinig, 2008). The assumption is given by:

$$(y_0, y_1) \perp d \mid x, \quad \forall x$$

---

$^{34}$ This assumption is also known as “ignorability of treatment”, “no omitted variable bias” (Rosenbaum and Rubin, 1983), “selection on observables” or “conditional independence” (Lechner, 1999; Caliendo and Kopeinig, 2008), “zero comparison-group bias”, “no comparison-group bias” or “conditional randomization” (Lee, 2005).

$^{35}$ Note that this is not the assumption one can directly test from the data.
Overlap or common support condition ensures that the probability of being assigned to the treatment or comparison group is different from zero for all units in the population (cf. figure 5.3). This means that there are individuals who share the same \( x \) across the treatment and comparison groups (Lee, 2005). This assumption is defined by:

\[
0 < Pr(d = 1 \mid x) < 1 \quad \forall x
\]  

(a2)

Under the strong ignorability, the \( ATET \) can be estimated as follows:

\[
ATET \equiv E\left[\frac{1}{d} - y_0 \mid d = 1\right] = E\left\{y_1 - y_0 \mid d = 1, Pr(x)\right\}
= E\left\{y_1 \mid d = 1, Pr(x)\right\} - E\left\{y_0 \mid d = 0, Pr(x)\right\} \mid d = 1
\]  

(5.5)

In practice, and in the case of binary treatment, the propensity score can be estimated using probit, logit, or discriminant score. The probit or logit models usually yield similar results. Hence, the choice is not too critical (Calendio and Kopeinig, 2008). Rosenbaum and Rubin (1983) argue that the discriminant matching and the propensity score matching are equivalent if the covariates \( x \) have a multivariate normal distribution. However, since most empirical studies have at least one qualitative independent variable, the multivariate normality is often ruled out.

\[
\text{Figure 5.3. Region of common support}
\]

Source: Adapted from Ravallion (2008).

- **Balancing score for multiple treatments**

The propensity score defined in equation 5.4 has been generalized by Imbens (2000). The generalized propensity score is the conditional probability of receiving a particular treatment given the pre-treatment variables:

\[
p(t, x) \equiv Pr\{T = t \mid x\} = E(d_t \mid x)
\]  

(5.6)
The main assumption required here is the weak unconfoundedness, which means that the assignment to treatment \( t \) is weakly unconfounded, given the pre-treatment variables \( x \). Imbens (2000) shows that if assignment to treatment \( t \) is weakly unconfounded given covariables \( x \), then, by the same argument as in the binary treatment case, assignment is weakly unconfounded given the generalized propensity score: \( d_t \perp (y_0, y_1t) \mid p(t, x) \), for all \( t \). In this case, one can estimate the average outcome by conditioning only on the generalized propensity score. Weak unconfoundedness, as noted by Imbens (2000), calls only for pairwise independence of treatment with each of the potential outcomes. Accordingly, CIA allows one to remove the other treatments and their participants from consideration, if the interest is solely in a specific pairwise-impact for corresponding subpopulations (Lechner, 2000).

In practice, in the case of the multiple treatments, the multinomial logit or multinomial probit can be used to estimate the propensity score. But, the multinomial probit model is preferable to the multinomial logit because the latter is based on stronger assumptions than the former. However, multinomial probit is computationally more burdensome, and for this reason, Lechner (2001) suggests the estimation a series of binomial models, using for instance simple logit. He compares the multinomial probit method and series of logit estimation and finds little difference in the relative performance of the methods. Lechner (2001) argues that the method based on a series of logit can be more robust since a misspecification in one of the series will not compromise all others, as would be the case in the multinomial probit approach. The shortcoming of this alternative is that the number of models to be estimated will increase as the number of treatment/options increases. This alternative (series of logit) is the one used in this study, as we are mainly interested in pairwise comparisons.

### 5.2.3. Propensity score matching: choosing a matching algorithm

Once the propensity score is estimated, one needs to choose the comparison unit(s) to match with each treatment unit. Various methods are available for this purpose such as one-to-one matching, in which each treatment unit is matched with one control unit, the nearest-neighbor matching (NNM) radius matching (RM), stratification matching (SM) and kernel matching (KM).

The NNM allocates to each individual in the treatment state one or many individuals in the comparison state that have (almost) the same value of selected characteristics. Once each treated unit is matched with one or many untreated, the difference between the outcome of the treated and the outcome of the matched control units is calculated. The \( ATET \) is then obtained by calculating the average of the differences. Two types of NNM are available: matching with replacement and matching without replacement. In NNM without replacement (NNMd), when an individual \( i \) in the treatment group is matched with an individual \( j \) in the control group, the untreated subject is removed from the sample. The process is repeated until all possible matches have been formed. The main problem in using the NNMd is that the estimates depend upon the
order in which observations get matched (Caliendo and Kopeinig, 2008). Also, following Smith and Todd (2005), NNMd increases the bias that results from using (on average) poorer matches, but reduces the variance which results from using more information to construct the potential outcome for each treated. Concerning the NNM with replacement (NNMw), when an individual in the treatment group is matched with one or many individuals in the control group, the untreated subjects are not removed from the sample. This process is repeated until all possible matches have been formed. The NNMw minimizes the propensity score distance between the matched comparison units and the treatment unit (Dehejia and Wahba, 2002), and thus, increases the average quality of matching and reduces the bias (Caliendo and Kopeinig, 2008).

It is worth noting that there are often, as in our study, continuous variables among the covariates used in estimating the propensity score. It follows, therefore, that the probability of finding individuals with the same propensity score is almost zero. Therefore, in using the NNM, one often imposes a tolerance level on the maximum propensity score distance (caliper) (Caliendo and Kopeinig, 2008), in order to avoid bad matching. NNM with caliper is one way of imposing a common support condition (Smith and Todd, 2005). For example, one can choose to match treated and control individuals on the first four digits of the propensity score. The main drawback of NNM with caliper is that it is impossible to know a priori the most suitable value of the caliper (Smith and Todd, 2005). In this study, we tried several values for the caliper until we obtained the caliper for which the total bias after matching was lower than the critical value of 20% (cf. Section 5.2.4 for more detail on the bias before and after matching).

In radius matching (RM), the potential outcome consists of the average outcome of all the treated units within a given caliper, rather than just the nearest neighbor (Dehejia and Wahba, 2002; Smith and Todd, 2005). In other words, each treated is matched only with the untreated whose propensity score is within a predefined neighborhood of the propensity score (radius) of the treated unit (Becker and Ichino, 2002).

The stratification matching (also termed interval matching, blocking or sub-classification) consists of dividing the range of variation of the propensity score in blocks such that within each block, treated and untreated units have, on average, the same propensity score (Becker and Ichino, 2002). Within each block, the difference between the average outcomes of the treated and the untreated is calculated. The ATET is obtained by averaging the average treatment effect of each block with weights given by the distribution of treated units across blocks.

The last matching algorithm described in this paragraph is Kernel Matching (KM). In this method, all treated are matched with a weighted average of all untreated with weights that are inversely proportional to the distance between the propensity scores of treated and untreated (Becker and Ichino, 2002). KM is like a weighted regression of the potential outcome on an intercept with weights given by the kernel weights (Smith and Todd, 2005). In the application of the KM approach, one must choose the kernel function and the bandwidth parameter (to be used in the kernel function).
Finally, all the algorithms described above have their advantages and drawbacks, and none of them is a priori superior to the others (Becker and Ichino, 2002). For this purpose, only the nearest-neighbor matching (NNM) with replacement (where each treated is matched with 2 nearest neighbors) and caliper was used in this study.

5.2.4. Propensity score matching: analyzing consistency in the estimation

The last step in the PSM method is to check the consistency of the estimation, e.g. by checking for overlap and by analyzing the matching quality.

- **Support region**

In the PSM, it is important to check for overlap and to determine the common support region. By definition, this region includes only those values of propensity scores that have positive density within both the treatment and control groups’ distributions (Smith and Todd, 2005). Various methods of analyzing this overlap are available in the literature, but the most commonly used is a visual analysis of the density distribution of the propensity score in the treatment and control groups.

- **Matching quality**

The matching methods as described above attempt to reduce the complexity of the pre-treatment variables by reducing the variables to only one, thereby avoiding the dimension problem. But, by reducing the dimension, there is an undeniable loss of information. Consequently, it is important to assess the quality of the matching methods by analyzing the capability of the matching procedure to balance the distribution of the relevant variables in both the treatment and control group. Several approaches are available in the literature to assess the matching quality, namely the standardized bias (SB), the pseudo-$R^2$ and the $t$-test. The main intention behind these different methods is to compare the situation before and after matching and to verify whether any differences remain after conditioning on the propensity score (Caliendo and Kopeinig, 2008). If differences remain after matching, then the PSM does not perform successfully and should be improved by adding, for example, other variables or interaction terms in the estimation of the propensity score.

The standardized bias (SB), for each covariate $x$, is defined as the difference of sample means in the treated and matched untreated subsamples as a percentage of the square root of the average of sample variances the treated and untreated groups (Rosenbaum and Rubin, 1985; Caliendo and Kopeinig, 2008). The SB before matching is given by:

$$B(Z) = 100 \frac{\bar{x}_1 - \bar{x}_0}{\sqrt{\frac{v_1(x) + v_0(x)}{2}}}$$

(5.7)
where $\bar{x}_1$ and $\bar{x}_0$ are the sample means for the treatment and comparison groups before matching, and $v_1(x)$ and $v_0(x)$ are the corresponding sample variances. The SB after matching is defined as follows:

$$B(Z) = 100 \frac{\bar{x}_{1M} - \bar{x}_{0M}}{\sqrt{v_{1M}(x) + v_{0M}(x)} / 2} \quad (5.8)$$

with $\bar{x}_{1M}$ and $\bar{x}_{0M}$ being the sample means for the treatment and comparison groups after matching, and $v_{1M}(x)$ and $v_{0M}(x)$ being the corresponding matched sample variances.

The main problem with using the SB approach is that there is no clear indication for the success of PSM. However, in empirical studies, it is often assumed that an SB below 3% or 5% after matching is acceptable (Caliendo and Kopeinig, 2008).

Another approach is to calculate the total bias before and after matching. Rosenbaum and Rubin (1985) argue that, after matching, the total bias greater than 20% should be considered as "large." The total bias reduction can be defined as:

$$BR = 100 \left( 1 - \frac{B_{\text{after}}}{B_{\text{before}}} \right) \quad (5.9)$$

where $B_{\text{before}}$ and $B_{\text{after}}$ are before and after matching, respectively.

As an alternative for assessing the matching quality, one can re-estimate the propensity score on the matched sample, i.e. only on treated and matched control and compare the pseudo-$R^2$’s before and after matching (Sianesi, 2004). After matching, the pseudo-$R^2$ should be relatively low, meaning that there are no systematic differences in the distribution of covariates between the treated and untreated groups (Sianesi, 2004). In addition to the pseudo-$R^2$, the likelihood ratio test can be performed on the joint significance of all regressors in the logit model. The null hypothesis should be rejected before matching and should not be rejected after matching (Caliendo and Kopeinig, 2008).

The $t$-test method for assessing the match quality is similar to the SB method. It is used to check if the mean of the covariates differ significantly between treated and control groups. The idea here is that before matching, the two groups can be different in $x$, but after matching the difference is supposed to be statistically insignificant, as the covariates should be balanced in both groups by the matching. Caliendo and Kopeinig (2008) argue that the shortcoming of the $t$-

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36 The pseudo-$R^2$ indicates how well the regressors $x$ explain the participation probability.
test is that the bias reduction before and after matching is not clearly visible. We do not use this method in this study.

5.3. **Empirical framework**

This section describes the procedure used to evaluate the impact of CBM and microfinance on rural households’ living conditions. It first describes the outcome variables and then the methods used to estimate the propensity score and to analyze the matching quality.

5.3.1. **The outcome variables: impact of poultry-based interventions on what?**

The effect of CBM and microfinance on five categories of indicators, namely indicators related to village poultry production, poverty, vulnerability, gender, and education are analyzed.

- **Outcome related to village poultry production**

Indicators related to village poultry production include the return over variable costs (gross margin) for the household and the “skill.” The former, for a given household $i$, is simply the sum of the gross margins of all poultry breeders who are members of the household. The gross margin is given by equation 4.2 (cf. chapter 4).

The second indicator (termed “skill”) is represented by an index obtained by combining a certain number of elements. In fact, as indicated in the introductory chapter of this thesis, the objective of the projects/programs supporting village poultry farming was to move producers from their subsistence-oriented logic to market or economic-oriented logic, i.e. the improvement of their entrepreneurship. This change in producers’ behavior should help them to manage their poultry better and thus increase their profit. In practice, we estimated that the desired behavioral change should start with the adoption of relevant innovations (vaccination, henhouses, improved feed, etc.) but also the management of the livestock (data recording, diagnosis of avian diseases for their prevention, cleaning of henhouses and know place where birds spent the night).

As summarized in table 5.1, one point was given to the breeder who adopted a given practice and zero otherwise. The total points obtained by the breeder are divided by 12 in order to maintain the index between 0 and 1, with 0 for breeders who are completely subsistence-oriented (no skill or non-adoption of any practice) and 1 for breeders who adopt all the practices, i.e. producers who are strongly market-oriented. Thus, the higher the value of the index, the higher the motivation and effort of the breeder. For a given household, the degree of economic orientation (or the skill level) corresponds to the average of the index, i.e. the sum over the indices of all breeders of the household divided by the number of breeders.
Impact of poultry-based interventions on rural households’ living conditions

Table 5.1. Description of variables used for economic orientation indicator

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>COCK</td>
<td>Have improved cockerel</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>CHICKH</td>
<td>Have chick-house</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>HENHH</td>
<td>Have henhouse</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>FEEDIM</td>
<td>Make improved feed for poultry</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>DIAGN</td>
<td>Call VPV or veterinarian for the diagnosis of poultry diseases</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>VACCIN</td>
<td>Vaccination of poultry</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>NIGHT</td>
<td>Know the place where birds spend their night</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>CLEANH</td>
<td>Cleaning of henhouse</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>FRECL</td>
<td>Frequency of henhouse cleaning</td>
<td>1 if ≥ 2 per month, 0=otherwise</td>
</tr>
<tr>
<td>GWATER</td>
<td>Give water to poultry</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>FWATER</td>
<td>Frequency of water distributed to poultry during dry seasons</td>
<td>1 if ≥ 3 per week, 0=otherwise</td>
</tr>
<tr>
<td>RECORD</td>
<td>Record the events occurring in his flock</td>
<td>1=yes, 0=no</td>
</tr>
</tbody>
</table>

- **Poverty / wellbeing**

The 2000 World Development Report (WDR, 2001: 15) defines poverty as pronounced deprivation in wellbeing. In other words, the notion of poverty is closed related to wellbeing, and is associated with a situation where a person’s wellbeing is low. It must be conceived of as a combination of both objective and subjective dimensions, which are located in the social and cultural relationships that all human beings in all societies are engaged in (McGregor et al., 2007). To be poor is “to be hungry, to lack shelter and clothing, to be sick and not cared for, to be illiterate and not schooled” (WDR, 2001: 15).

In this study, we used household consumption expenditure as indicator of the household’s poverty level. For this household expenditure, we assumed that, households faced the same prices for inputs within the same region, since we undertook a cross-households analysis in one-year time. We also postulate that all households buy their goods at the same market, which means they faced the same prices. The estimated household expenditures include expenditure on food (products consumed at home, cafeterias, canteens and restaurants), school expenses (school fees, breakfast and pocket money, textbooks, school uniforms, other school items), health care (medical items and drugs, payment of medical services, indigenous treatment costs), social expenses (wedding, funeral and other ceremonies, money/gifts to people who are not members of households), expenses on durable goods (house, furniture, jewelry, bikes, motorcycles, radios, etc.), footwear and clothes and others products (cigarettes, alcohol and soft drinks, transport/taxi, paid services, lottery, electricity, kerosene, soap, candles, etc.). We also include the opportunity value of self-produced goods consumed by the household, i.e. the amount of money (in FCFA) the household would pay if the goods were purchased at the most nearest market (cf. detail in questionnaire 1, in appendix 3).
Household expenditure is measured as expenditures per ‘equivalent adult.’ For this purpose, various weights were given to children according to their age. We used the same weights as those suggested by Glewwe (1988) for a developing country setting: children under the age of seven count as 0.2 of an adult; ages 7-13 count as 0.3; and ages 13-17 as 0.5. The sum of these weights for each household was used to divide household expenditures to obtain a measure of the household’s wellbeing. Since we did not have data on the intra-household distribution of goods and services, we assumed that all members experience the same level of wellbeing within the same household.

It is worth noting that, in this study, we preferred household expenditure to income. Indeed, following Glewwe (1988: 4), using consumption rather than income data is supported by the argument that the former is a better indicator of lifecycle welfare than the latter, because income may fluctuate over short periods of time, while consumption is distributed more evenly ("smoothed") over time. Furthermore, for Glewwe (1988: 4), consumption data are likely to be more reliable than income data because the former constitute less sensitive information from the perspective of the survey respondents. Coudouel et al. (2002) and the World Bank (2010a) argue that consumption is a better outcome indicator than income, because (i) actual consumption is more closely related to a person’s well-being in the sense of having enough to meet current basic needs; (ii) consumption expenditures not only reflect the goods and services that a household can purchase based on its current income, but also whether that household can access credit markets. Finally, in the context of measuring welfare in developing countries, consumption data were preferable because the difficulties of measuring income are much more severe than those for measuring consumption, especially for rural households whose income is largely earned through self-employment in agriculture (Deaton, 1997: 149). Income, especially agricultural income, can be extremely variable, and a farmer’s income in any month is a poor indicator of living standards for that month. Furthermore, income may be underreported because farmers may be afraid of the tax authorities.

Apart from household expenditures, three other poverty indicators were used, namely the incidence of poverty (the headcount ratio), the poverty gap and the severity of poverty. These indicators are calculated using Foster-Greer-Thorbecke (FGT) poverty index which, for a household, is given by (Foster et al., 1984):

$$I_{FGT} = \begin{cases} \left( \frac{z - W}{z} \right)^{\alpha} & \text{if } y < z \\
0 & \text{otherwise} \end{cases}$$

(5.9)

where $z$ is the ‘poverty line,’ $y$ the income of the household and $\alpha$ a parameter. When:

- $\alpha = 0$, the index is simply a binary indicator of whether the farmer is below the poverty line or not. The poverty line is defined by the state-level poverty line, i.e. FCFA 109,400 per capita, per year (INSAE, 2009). This allowed us to obtain the share of households
whose consumption per capita is below the poverty line, i.e. the share of households that cannot afford to buy a basic basket of goods.

- $\alpha = 1$, the index is a measure of the ‘poverty gap,’ which is also known as the depth of poverty. The poverty gap provides information regarding how far off households are from the poverty line and captures the mean aggregate consumption shortfall relative to the poverty line across the whole population (World Bank, 2010b).

- $\alpha = 2$, $I_{FGT}$ equals the squared poverty gap, which is used as a measure of the severity of poverty. This takes into account not only the average distance separating the poor from the poverty line (the poverty gap), but also inequality among the poor; i.e. a higher weight is placed on the households which are further away from the poverty line (World Bank, 2010b).

- **Household’s vulnerability**

The concept of vulnerability is not equivalent to the concept of poverty. Indeed, even though most of the poor households are among the most vulnerable, not all vulnerable households are poor. Moser (1998) argues that poverty is a static concept (poverty measures are generally fixed in time), whereas vulnerability is a dynamic concept. Vulnerability is more suitable for capturing changes as “people move in and out of poverty” (Moser, 1998).

Besides, Moser (1998) states that vulnerability analysis consists of identifying, not only threats, but also responsiveness to exploit opportunities and resist or recover from the negative effects of a changing environment. The means of resistance are the assets and entitlements that households can mobilize and manage in the face of hardship (Moser, 1998). Barnes (1996) shows that the composition of a household stock of assets is an indicator of its strategies for maximizing present and future well-being.

According to Garikipati (2008), measures of vulnerability are highly contextual and indicators relevant to a certain society may be of little consequence to another. For this purpose, during various focus group interviews carried out in the research villages, the interviewees were asked to define vulnerability and list the main factors used in their definition. In general, most of the factors indicated by village dwellers were mainly related to material means (farm equipment, bicycle, motorcycle, radio, car, etc.), the quality of the household’s house and food shortage. Based on these elements, a series of detailed questions (twelve in total) relating to various aspects of vulnerability were included in the questionnaire used during the quantitative survey. The responses to the questions were codified: 1 if the household owned a given asset and 0 otherwise (table 5.2). However, the farmer’s own perception of the economic situation of his household (compared with how it was five years ago) and food security were coded 0, 0.25, 0.5, 0.75 and 1, depending on the extent.
Based on these variables, we constructed four types of indicators of vulnerability: material, dwelling, economic and social. All these indicators were then collated to construct the overall vulnerability indicator. In other words, for each household, the total value was divided by 22 (the maximum value possible) in order to obtain a vulnerability indicator which ranges from 0 to 1. Thus, the higher the indicator, the less vulnerable the household.

Table 5.2. Description of variables used in vulnerability indicator

<table>
<thead>
<tr>
<th>Variables</th>
<th>Descriptions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RADIO</td>
<td>Radio</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>TELE</td>
<td>Television</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>CEL</td>
<td>Mobile phone</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>MOTO</td>
<td>Motorcycle</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>BIKE</td>
<td>Bicycle</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>CAR</td>
<td>Car</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>TRAC</td>
<td>Cart/traction</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>REFR</td>
<td>Fridge</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td><strong>Dwell</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELEC</td>
<td>Electricity at home</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>HDWELL</td>
<td>Ownership of household’s house</td>
<td>1 = If the household owns the dwelling, 0=otherwise</td>
</tr>
<tr>
<td>THOUS</td>
<td>Type of house</td>
<td>1= good or medium, 0=low standing</td>
</tr>
<tr>
<td>WALL</td>
<td>Material of the house’s wall</td>
<td>1= concrete material (brick of cement/ground), 0=otherwise (clay, straw, etc.)</td>
</tr>
<tr>
<td>RCAST</td>
<td>Roughcast of the house’s wall</td>
<td>1= Entirely/partly, 0=None</td>
</tr>
<tr>
<td>ROOF</td>
<td>Material of the house’s roof</td>
<td>1= Slab/corrugated iron/tile, 0=Otherwise</td>
</tr>
<tr>
<td>SROOF</td>
<td>State of the roof</td>
<td>0= If dwelling has poor quality roofing, 1=otherwise</td>
</tr>
<tr>
<td>COOK</td>
<td>Cooking method</td>
<td>1=Kerosene/electricity/gas, 0=otherwise</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECOMH</td>
<td>Economic situation of the household compared to how it was 5 years ago</td>
<td>0= Much worse now, 0.25= little worse now, 0.50=No change, 0.75=little better now, 1= much better now</td>
</tr>
<tr>
<td>FOODS</td>
<td>Number of times the household encounters problems in satisfying food needs during the last year</td>
<td>0=Always, 0.25=very often, 0.5=often, 0.75=Rarely, 1=Never</td>
</tr>
<tr>
<td>OFARM</td>
<td>Have non-agro business</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEDD</td>
<td>Investment in wedding during last year</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>FUNER</td>
<td>Investment in funeral ceremonies during last year</td>
<td>1=yes, 0=no</td>
</tr>
<tr>
<td>GIFT</td>
<td>Help neighbor during last year (with cash or in-kind or both)</td>
<td>1=yes, 0=no</td>
</tr>
</tbody>
</table>

It is worth noting that we included social vulnerability in the vulnerability indicators because of its importance in Benin’s society. Indeed, in Benin, organizing and funding a traditional ceremony or funeral is a sign of prosperity or high social status. The welfare of a household is recognized by the number of animals (cattle, small ruminants, pigs, poultry) slaughtered during a traditional ceremony. Furthermore, in Benin, like most West African countries, a mother/father
would find money to buy a funeral cloth by keeping a child out of school (Ohene, 2010), as keeping a child in school does not earn as much social status as organizing a funeral.

Also, as mentioned in section 2.1.2 (and table 2.3), in the North of Benin, the number of children is a sign of well-being. Indeed, land is sufficiently available and peasants need manpower to cultivate it. So taking a new wife is a sign that the household has earned enough money during the last agricultural campaign.

- **Gender empowerment**

The projects analyzed in this study particularly targeted the involvement of women, even if men also took an active part in the implementation of the projects. The basic argument behind this was that women are more likely to share the benefits gained with others members of their household. Furthermore, in addition to the economic benefits, women’s increasing role in the household economy can lead to their empowerment (Garikipati, 2008).

The United Nations International Research and Training Institute for the Advancement of Women (UN-INSTRAW, 2010) argues that empowerment is both a process and an outcome. It implies that women, but also men, are taking control of their lives: setting their own agendas, gaining skills, increasing self-confidence, solving problems, and developing self-reliance (UN-INSTRAW, 2010). Ranjani et al. (2008) note that the process of a woman’s empowerment involves making changes so that she can exercise more ‘power to shape her life,’ notably control of resources, access to markets, and the opportunity to shape institutional norms and practices. In contrast, to be disempowered means to be denied choice (Kabeer, 2005).

As in the case of vulnerability, measures of gender empowerment are highly contextual and indicators relevant to a certain society may be of little consequence to another (Garikipati, 2008). In the questionnaire used in this study, two categories of gender empowerment were considered (table 5.3), namely participation in children’s schooling (9 variables), and control over finances and the household’s assets (10 variables). In each of these cases, the variables were collated to construct the gender empowerment indicator. The sum of the indicators was divided by 9 for children’s schooling and by 10 for control over finances and the household’s assets, respectively. For the composite empowerment (overall empowerment), the total value was divided by 19 (the maximum value possible). In all cases, indicator values varied between 0 and 1.
Table 5.3. Description of variables used for gender empowerment indicators

<table>
<thead>
<tr>
<th>Variables</th>
<th>Descriptions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control over finances and households’ assets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIVES</td>
<td>Own livestock (excludes poultry)</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>SCROP</td>
<td>Kept the money from sale of crop produced</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>SLIVES</td>
<td>Kept the money from sale of livestock produced</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>INCOP</td>
<td>Kept the money from sale of poultry rearing</td>
<td>1=herself, 0=otherwise</td>
</tr>
<tr>
<td>HHINC</td>
<td>Contribution in HH income</td>
<td>1 if ≥ 25%, 0 otherwise</td>
</tr>
<tr>
<td>PERM</td>
<td>Obliged to seek permission from spouse before taking loan</td>
<td>1=no, 0 otherwise</td>
</tr>
<tr>
<td>AMCRE</td>
<td>Person who specifies the amount to borrow</td>
<td>1=herself, 0=otherwise</td>
</tr>
<tr>
<td>ACTP</td>
<td>Person who specifies the activity to undertake with the loan</td>
<td>1=herself or jointly with other,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0=otherwise</td>
</tr>
<tr>
<td>HUSTW</td>
<td>If husband also takes care of his wife’s flock</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>HHBUD</td>
<td>Henhouse building</td>
<td>1=herself or jointly with other,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0=otherwise</td>
</tr>
<tr>
<td><strong>Kids’ schooling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSUPL</td>
<td>Contribution in school supplies</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>PSSUPL</td>
<td>Percentage of the contribution in school supplies</td>
<td>1 if ≥ 25%, 0 otherwise</td>
</tr>
<tr>
<td>BREAK</td>
<td>Contribution in children’s breakfast</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>PBREAK</td>
<td>Percentage of the contribution in children’s breakfast</td>
<td>1 if ≥ 25%, 0 otherwise</td>
</tr>
<tr>
<td>FEES</td>
<td>Contribution in school fees</td>
<td>1=yes, 0 otherwise</td>
</tr>
<tr>
<td>PFEES</td>
<td>Percentage of the contribution in school fees</td>
<td>1 if ≥ 25%, 0 otherwise</td>
</tr>
<tr>
<td>GSCOOL</td>
<td>Person who decides whether a given girl can go to school</td>
<td>1= wife or jointly with the husband,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 otherwise</td>
</tr>
<tr>
<td>BSCOOL</td>
<td>Person who decides whether a boy can go to school</td>
<td>1= wife or jointly with the husband,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 otherwise</td>
</tr>
<tr>
<td>SUPED</td>
<td>Person who supervises the education of children</td>
<td>1= wife or jointly with the husband,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 otherwise</td>
</tr>
</tbody>
</table>

- **Education**

Various indicators can be used to assess the impact of a given program on education. In this study, the household’s expenditure on children’s schooling (school fees + breakfast + school supplies + other such as subscription and transport) were used. We only considered the investment in education at secondary school. Indeed, since primary education in Benin is relatively free (even though people have to pay some subscriptions), one may not be able to perceive the effect of a given intervention by analyzing the impact at the primary school level.

5.3.2. Estimating the propensity score

Let $t$ be the treatments, with $t = 0$ for no treatment (baseline, i.e. households that have not participated in CBM or in microfinance programs), $t = 1$ for NPBM treatment (non-participants in CBM who received microfinance), $t = 2$ for CBM treatment (households that have participated in CBM but did not receive microfinance), $t = 3$ for CBM-NPBM treatment (participants in CBM that received microfinance other than poultry-based microfinance) and $t = 4$ for CBM-
PBM treatment (participants in CBM who received PBM). In this study, we only implemented pairwise comparisons, i.e. all treatments \((t \neq 0)\) were compared to the control households \((t = 0)\).

The logit model was used for the estimation of the balancing score, since we only carried out pairwise comparisons. The model is given by:

\[
\Pr(d_i = 1 | x) = \frac{e^{x'\beta}}{1 + e^{x'\beta}}.
\] (5.10)

with \(x\) being the characteristics of the household. An important step in the estimation of these models is the selection of the covariates \(x\). Imbens and Wooldridge (2009) argue that the literature is not very helpful in this respect, except for warnings about including covariates that are themselves influenced by the treatment. In other words, there is no theoretical basis for how to choose the covariates \(x\) to satisfy the identifying assumptions (Todd, 2008). Consequently, researchers have just included covariates without much systematic effort to find more compelling specifications (Imbens and Wooldridge, 2009). However, Todd (2008) notes that the covariates should normally be those which affect participation in the program as well as the outcome variable.

In this study, the explanatory variables used in the logit model for the propensity score estimation include the demographic characteristics of the household (family size, number of children less than 14 years, number of adult females more than 14 years old); characteristics of the head of the household (sex, education, literacy, age); his/her spouse’s characteristics (age, education); land assets (land owned in hectares, relative subsistence pressure, which corresponds to the amount of land owned per adult equivalent); and other characteristics (distance to the nearest town, and a regional dummy in order to take account of differences across regions). The variables used in the estimation of the propensity score, as well as the results of the logit regressions, are presented in appendix 5.

The impact of the treatment on indicators for poverty, vulnerability and the outcomes of poultry production were evaluated by using the same logistic regression model for all indicators. These are different from those used for assessing the impacts of different treatments on education and gender empowerment. This is due to the fact that all households do not have children. Therefore, households without children were not included in the assessment of the impacts of different programs on education. Households with single males or females, and those in which women were absent, or did not live in the household at the time of the survey, were not included in the assessment of the impact of treatment on gender empowerment.

The estimation of the average treatment effects was carried out using the econometrics software Stata/SE 10.0 for Windows (StataCorp, 2007). The main command used was \(psmatch2\) of Leuven and Sianesi (2003). Also, as a matching algorithm, we used the nearest-neighbor matching (as stated in section 5.2.3) with replacement, so that each treated is matched with the 2
nearest neighbors and a caliper is used in order to avoid bad matching if the closest nearest neighbor is far away. As indicated in section 5.2.3, we tried several values for the caliper until we identified the caliper for which the total bias after matching was lower than the critical value of 20%.

It is worth noting that the aim of the propensity score estimation is not to obtain a precise prediction of selection for treatment, but rather to balance the distributions of the covariates in the treated group and the control groups. Thus, in this study, an interpretation of the propensity score estimations was not undertaken.

5.3.3. Assessing the quality of the propensity score matching

- **Overlap and common support**

In this study, the visual analysis of the density distribution of the propensity score in the treated and control groups is used to analyze the common support assumption. We compare the minima and maxima of the propensity scores. Observations that had propensity scores which were lower than the minimum or higher than the maximum in the opposite group were removed from the sample. Figure 5.4, 5.5 and 5.6 show the distribution of the estimated propensity scores for participant and non-participant groups for the four treatments assessed in this study. It is clear from the observation of this figure that there is sufficient overlap between the treated and the control groups. The matching procedure is only performed on the region of common support.

- **Match quality**

After matching, we use the balancing test to check whether the differences in the covariates in the treated and control groups in the matched sample have been eliminated. If the covariates are similar after matching, then the matched comparison group can be considered as plausibly counterfactual (Lee, 2008). For this purpose, three types of indicators are used to analyze the match quality, in particular the median absolute bias, the pseudo $R^2$, and the likelihood ratio. Tables 5.4, 5.5 and 5.6 indicate that the standardized bias, before the matching, ranges between 13% and 51%. After the matching, the median absolute bias is between 7% and 18%. Given that Rosenbaum and Rubin (1985) suggested a critical level of 20%, the matching quality seems to be acceptable.

After matching, the pseudo $R^2$ values are relatively low in all cases (tables 5.4, 5.5 and 5.6). These tables also present the values of the likelihood ratio (LR) test of the joint significance of all the regressors in the logit model of propensity score estimation before and after matching. The observation of these values indicates that they are significant before matching, but are not significant after matching. In other words, the LR indicates that the null hypothesis is not rejected after matching.
All in all, the joint combination of the three indicators (bias reduction, pseudo $R^2$ and LR) allows us to say that there is no significant difference in the distribution of the covariates after matching. In other words, the non-significant value of the likelihood ratio test, the relatively low pseudo $R^2$ values and the relatively low values of the median absolute bias after matching imply that there is no systematic difference in the distribution of covariates between treated and untreated after matching.

**Figure 5.4. Distribution of the propensity score for treated and control households (poultry, poverty, and vulnerability)**
Figure 5.5. Distribution of the propensity score for treated and control households (gender empowerment)

Figure 5.6. Distribution of the propensity score for treated and control households (education)
Table 5.4. Indicators of covariate balancing (for the propensity score used for poultry, poverty, and vulnerability), before and after matching

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Caliper</th>
<th>Median absolute bias before matching</th>
<th>Median absolute bias after matching</th>
<th>(Total) % [bias] reduction</th>
<th>Pseudo $R^2$ (unmatched)</th>
<th>Pseudo $R^2$ (matched)</th>
<th>LR chi-square (unmatched)</th>
<th>LR chi-square (matched)</th>
<th>Number of observations on common support</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM x PBM</td>
<td>0.09</td>
<td>13.33</td>
<td>12.66</td>
<td>5.03</td>
<td>0.615</td>
<td>0.091</td>
<td>185.82 (0.000)</td>
<td>14.83 (0.786)</td>
<td>110 59</td>
</tr>
<tr>
<td>CBM x NPBM</td>
<td>0.09</td>
<td>46.67</td>
<td>13.33</td>
<td>71.44</td>
<td>0.260</td>
<td>0.052</td>
<td>22.73 (0.004)</td>
<td>1.86 (0.985)</td>
<td>110 13</td>
</tr>
<tr>
<td>CBM x NM</td>
<td>0.08</td>
<td>22.03</td>
<td>12.70</td>
<td>42.35</td>
<td>0.391</td>
<td>0.088</td>
<td>50.57 (0.000)</td>
<td>4.62 (0.948)</td>
<td>110 19</td>
</tr>
<tr>
<td>Non CBM x NPBM</td>
<td>0.09</td>
<td>26.93</td>
<td>8.70</td>
<td>67.69</td>
<td>0.304</td>
<td>0.056</td>
<td>57.56 (0.000)</td>
<td>6.34 (0.998)</td>
<td>110 41</td>
</tr>
</tbody>
</table>

Figures in parentheses are $p$-value of LR.

LR= likelihood ratio, CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, NM: No microfinance.

Table 5.5. Indicators of covariate balancing (for the propensity score used for gender empowerment), before and after matching

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Caliper</th>
<th>Median absolute bias before matching</th>
<th>Median absolute bias after matching</th>
<th>(Total) % [bias] reduction</th>
<th>Pseudo $R^2$ (unmatched)</th>
<th>Pseudo $R^2$ (matched)</th>
<th>LR chi-square (unmatched)</th>
<th>LR chi-square (matched)</th>
<th>Number of observations on common support</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM x PBM</td>
<td>0.70</td>
<td>14.34</td>
<td>7.18</td>
<td>49.93</td>
<td>0.659</td>
<td>0.091</td>
<td>172.66 (0.000)</td>
<td>10.05 (0.967)</td>
<td>93 40</td>
</tr>
<tr>
<td>CBM x NPBM</td>
<td>0.09</td>
<td>51.78</td>
<td>14.36</td>
<td>72.27</td>
<td>0.398</td>
<td>0.189</td>
<td>26.15 (0.001)</td>
<td>3.67 (0.886)</td>
<td>93 7</td>
</tr>
<tr>
<td>CBM x NM</td>
<td>0.70</td>
<td>16.39</td>
<td>10.15</td>
<td>38.07</td>
<td>0.416</td>
<td>0.190</td>
<td>45.34 (0.000)</td>
<td>10.02 (0.439)</td>
<td>93 19</td>
</tr>
<tr>
<td>Non CBM x NPBM</td>
<td>0.08</td>
<td>27.88</td>
<td>14.72</td>
<td>47.20</td>
<td>0.318</td>
<td>0.113</td>
<td>48.51 (0.000)</td>
<td>8.76 (0.977)</td>
<td>93 29</td>
</tr>
</tbody>
</table>

Figures in parentheses are $p$-value of LR.

LR= likelihood ratio, CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, NM: No microfinance.

Table 5.6. Indicators of covariate balancing (for the propensity score used for expenditure on education), before and after matching

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Caliper</th>
<th>Median absolute bias before matching</th>
<th>Median absolute bias after matching</th>
<th>(Total) % [bias] reduction</th>
<th>Pseudo $R^2$ (unmatched)</th>
<th>Pseudo $R^2$ (matched)</th>
<th>LR chi-square (unmatched)</th>
<th>LR chi-square (matched)</th>
<th>Number of observations on common support</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM x PBM</td>
<td>0.07</td>
<td>18.72</td>
<td>12.15</td>
<td>35.10</td>
<td>0.639</td>
<td>0.147</td>
<td>110.78 (0.000)</td>
<td>11.17 (0.918)</td>
<td>62 29</td>
</tr>
<tr>
<td>CBM x NM</td>
<td>0.07</td>
<td>33.04</td>
<td>14.05</td>
<td>57.48</td>
<td>0.395</td>
<td>0.202</td>
<td>31.30 (0.000)</td>
<td>7.27 (0.699)</td>
<td>62 13</td>
</tr>
<tr>
<td>Non CBM x NPBM</td>
<td>0.08</td>
<td>21.54</td>
<td>18.45</td>
<td>14.35</td>
<td>0.334</td>
<td>0.198</td>
<td>42.41 (0.002)</td>
<td>18.14 (0.578)</td>
<td>62 33</td>
</tr>
</tbody>
</table>

Figures in parentheses are $p$-value of LR. The impact of CBM x NPBM was not calculated because the number of treated was very low.

LR= likelihood ratio, CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, NM: No microfinance.
• **Estimation of standard errors**

The last element presented in this paragraph is the estimation of standard errors of the treatment effect. The main problem is that the estimated variance of \( ATET \) (average treatment effect on treated) should also include the variance related to the estimation of the propensity score and the imputation of the common support (Caliendo and Kopeinig, 2008). There are several approaches that can be used to estimate the variance of average treatment effects, but the most commonly used is the bootstrap variance, which has rarely been formally justified, although in many cases it is likely to be valid given that many of the estimators are asymptotically linear (Imbens and Wooldridge, 2009). So, this study used the bootstrap method (with 2,000 replications) to calculate the standard error of the treatment effect.

In practice, the bootstrap principle is to perform in the original sample, a series (say \( m \)) of random sampling, simple, independent of each other and with replacement. Each bootstrap draw includes the re-estimation of \( ATET \), as well as the propensity score and common support. Repeating the bootstrapping \( m \) times leads to \( m \) estimated of \( ATET \) whose distribution approximates the sampling distribution, and thus the standard error, of the population mean (Caliendo and Kopeinig, 2008).

### 5.4. Description of surveyed households and items which they spend the money from poultry production on

#### 5.4.1. Description of breeders’ households

Roughly 10% of the surveyed households are headed by females compared to 90% which are headed by males (table 5.7). The highest percentage of female-headed households is found among the participants in CBM who received non-poultry based microfinance with about 21% female-headed households. The average age of the head of the household ranges from 46 years (for participants in CBM who received no credit) to 49 years for the control.

About 45% of the household heads have received formal education, with the lowest value observed among the control group (roughly 36%). The highest rate of education, 60%, is noted among participants in CBM who did not receive credit.

The average number of children in the surveyed households was 3. The highest and significant value (4 children) is observed for the ‘non-participants in CBM who received non-poultry based microfinance. The number of adult females (above 14 years old) is approximately 2 people. The ‘participants in CBM who received non-poultry based microfinance’ show the lowest number of adult females (about one) and the lowest household size (about 5 people per household).

The education level of spouses and their age are almost the same across the treatments, with only one significant difference. The relative subsistence pressure (i.e. ha of land per adult equivalents)
is one hectare per adult equivalent, with the lowest value (0.6 ha) noted for non-participants in CBM who received NPBM and ‘participants in CBM who received non-poultry based microcredit.’ The same tendency is observed for the amount of land owned: lowest value for participants in CBM who received NPBM (1.8 ha) and the highest value for participants in CBM who received PBM (4.6 ha).

Table 5.7. Some characteristics of the surveyed households

<table>
<thead>
<tr>
<th></th>
<th>No credit non-CBM (n=110)</th>
<th>CBM x PBM (n=103)</th>
<th>CBM x NPBM (n=14)</th>
<th>CBM x NM (n=25)</th>
<th>Non CBM x NPBM (n=46)</th>
<th>Total (n=298)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of the household head %</td>
<td>91.8</td>
<td>88.0</td>
<td>78.6</td>
<td>92.0</td>
<td>91.3</td>
<td>89.8</td>
</tr>
<tr>
<td>t-test</td>
<td>-0.94</td>
<td>-1.58</td>
<td>0.03</td>
<td>-0.11</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Age of the household head year</td>
<td>(14.6)</td>
<td>(13.7)</td>
<td>(16.7)</td>
<td>(13.7)</td>
<td>(13.3)</td>
<td>(14.1)</td>
</tr>
<tr>
<td>t-test</td>
<td>-0.52</td>
<td>-0.36</td>
<td>-0.93</td>
<td>-0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education of the household head %</td>
<td>35.5</td>
<td>46.3</td>
<td>57.1</td>
<td>60.0</td>
<td>50.0</td>
<td>44.6</td>
</tr>
<tr>
<td>t-test</td>
<td>1.63</td>
<td>1.58</td>
<td>2.29**</td>
<td>1.70*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children (below 14 years old) Number</td>
<td>(2.4)</td>
<td>(2.6)</td>
<td>(1.8)</td>
<td>(1.7)</td>
<td>(2.4)</td>
<td>(2.4)</td>
</tr>
<tr>
<td>t-test</td>
<td>0.34</td>
<td>-1.63</td>
<td>0.77</td>
<td>1.92*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult female (above 14 years old) Number</td>
<td>(1.7)</td>
<td>(1.8)</td>
<td>(0.9)</td>
<td>(1.8)</td>
<td>(1.4)</td>
<td>(1.7)</td>
</tr>
<tr>
<td>t-test</td>
<td>0.03</td>
<td>-1.71*</td>
<td>1.35</td>
<td>0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household size Number</td>
<td>7.5</td>
<td>7.6</td>
<td>4.9</td>
<td>8.7</td>
<td>8.6</td>
<td>7.7</td>
</tr>
<tr>
<td>t-test</td>
<td>0.17</td>
<td>-2.45**</td>
<td>1.31</td>
<td>1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative subsistence pressure ha per adult equivalents</td>
<td>1.1</td>
<td>1.2</td>
<td>0.6</td>
<td>0.8</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>t-test</td>
<td>0.59</td>
<td>-1.83*</td>
<td>-1.38</td>
<td>-3.36***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land owned ha</td>
<td>4.3</td>
<td>4.6</td>
<td>1.8</td>
<td>4.2</td>
<td>2.7</td>
<td>4.1</td>
</tr>
<tr>
<td>t-test</td>
<td>0.69</td>
<td>-2.65***</td>
<td>-0.11</td>
<td>-2.86***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of income from off-farm %</td>
<td>1.9</td>
<td>5.6</td>
<td>2.9</td>
<td>6.6</td>
<td>5.8</td>
<td>4.2</td>
</tr>
<tr>
<td>t-test</td>
<td>2.16**</td>
<td>0.38</td>
<td>2.26**</td>
<td>1.94*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to nearest main town km</td>
<td>21.6</td>
<td>21.6</td>
<td>5.6</td>
<td>22.1</td>
<td>17.1</td>
<td>20.2</td>
</tr>
<tr>
<td>t-test</td>
<td>0.01</td>
<td>-4.99***</td>
<td>0.18</td>
<td>-2.04**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of the spouse Year</td>
<td>34.9</td>
<td>35.3</td>
<td>26.6</td>
<td>32.0</td>
<td>34.9</td>
<td>34.4</td>
</tr>
<tr>
<td>t-test</td>
<td>0.17</td>
<td>-1.63</td>
<td>-0.73</td>
<td>-0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education of spouse %</td>
<td>10.9</td>
<td>19.4</td>
<td>21.4</td>
<td>16.0</td>
<td>19.6</td>
<td>16.2</td>
</tr>
<tr>
<td>t-test</td>
<td>1.76</td>
<td>1.13</td>
<td>0.71</td>
<td>1.44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, NM= No Microfinance. t-tests are for comparison between treatment and the control groups.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

(): Figures in parentheses are standard deviation.
On average, the surveyed households are situated about 20 km from the nearest town. Participants in CBM who received NPBM seem to be closer (about 6 km) to town than the participants in CBM who received PBM (22 km) and the control households (about 22 km). Furthermore, about 85% of households were engaged in crop production as the main activity, compared to 3% engaged in trade as the main activity. Other activities included handicraft, dressmaking, motorcycle taxi, etc.

It is important to note that, concerning the access and the use of the financial capital, the percentage of women who received credit is considerably higher than men: around 60% women compared to 19% men. In the same way, the proportion of women who received credit is higher in households that participated in CBM (66%) than in non-participant households (53%).

5.4.2. Items which surveyed households spend the money from poultry production on

Village poultry breeders were asked to indicate how they invested the income earned from poultry. The results (table 5.8) show that 97% used the income gained through poultry to finance health, with 100% for all participants in CBM.

The second most popular item on which households spend the income generated through poultry production is food, with roughly 86% of the surveyed households. The focus groups discussion with the producers revealed that the income from poultry is used for food mainly in April and May in the South, and between May and July in the North. This can be explained by the fact that these periods are times of hardship when the coffers are empty. As explained in section 6.5.1, most farmers sell the majority of their poultry products at the market during these periods. This results in a decrease in the chicken price due to an increase in supply.

Most of the households also use to invest poultry income in children education (roughly 81% of them). Poultry selling for kids’ education occur mainly in September and October, i.e. when school year started. During this period, many village breeders bring their products to the market, which causes a slight decrease in chicken selling prices (cf. section 6.5.1 for more details).

These results are in agreement with the observations of Kryger et al. (2010: 53) who indicate that the use of “poultry savings,” also termed “livestock banking,” is one way of mitigating income deficits that may occur in certain seasons. Expenses related to children’s school attendance, health care and the like are noted as occasions when “poultry savings” are cashed in (Kryger et al., 2010: 53). Given that there is a risk of loss relating to the use of poultry as savings (partly due to the high mortality rate) the use of poultry for this purpose shows that no, or few, alternative saving strategies are available.

The surveyed farmers also utilize money from the sale of poultry for emergencies and the purchase of clothes and jewelry. Few of them use the income from poultry for travel (roughly 21
%), or for house construction (roughly 23% of them). About 35% of the surveyed households used the money from poultry production to purchase sheep breeds for rearing.

Table 5.8. Items which surveyed households spend the money from poultry production on

<table>
<thead>
<tr>
<th>Item</th>
<th>Control (110)</th>
<th>CBM x PBM (103)</th>
<th>CBM x NPBM (14)</th>
<th>CBM x NM (25)</th>
<th>Non CBM x NPBM (46)</th>
<th>Total (298)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schooling of kids</td>
<td>69.1</td>
<td>83.5</td>
<td>92.9</td>
<td>100.0</td>
<td>87.0</td>
<td>80.5</td>
</tr>
<tr>
<td>Doctor/Health</td>
<td>94.5</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>93.5</td>
<td>97.0</td>
</tr>
<tr>
<td>Travel</td>
<td>21.8</td>
<td>22.3</td>
<td>21.4</td>
<td>24.0</td>
<td>13.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Emergencies</td>
<td>75.5</td>
<td>62.1</td>
<td>78.6</td>
<td>84.0</td>
<td>54.3</td>
<td>68.5</td>
</tr>
<tr>
<td>House building</td>
<td>18.2</td>
<td>25.2</td>
<td>14.3</td>
<td>32.0</td>
<td>26.1</td>
<td>22.8</td>
</tr>
<tr>
<td>Clothes and jewels</td>
<td>71.8</td>
<td>82.5</td>
<td>92.9</td>
<td>92.0</td>
<td>80.4</td>
<td>79.5</td>
</tr>
<tr>
<td>Food</td>
<td>80.9</td>
<td>86.4</td>
<td>100.0</td>
<td>100.0</td>
<td>82.6</td>
<td>85.6</td>
</tr>
<tr>
<td>Agricultural activities</td>
<td>56.4</td>
<td>68.0</td>
<td>85.7</td>
<td>88.0</td>
<td>63.0</td>
<td>65.4</td>
</tr>
<tr>
<td>Recharge for mobile phone</td>
<td>12.7</td>
<td>34.0</td>
<td>21.4</td>
<td>40.0</td>
<td>30.4</td>
<td>25.5</td>
</tr>
<tr>
<td>Purchase of parent animals:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>4.5</td>
<td>2.9</td>
<td>7.1</td>
<td>12.0</td>
<td>15.2</td>
<td>6.4</td>
</tr>
<tr>
<td>Goat</td>
<td>9.1</td>
<td>12.6</td>
<td>7.1</td>
<td>12.0</td>
<td>8.7</td>
<td>10.4</td>
</tr>
<tr>
<td>Sheep</td>
<td>22.7</td>
<td>39.8</td>
<td>42.9</td>
<td>48.0</td>
<td>43.5</td>
<td>34.9</td>
</tr>
<tr>
<td>Rabbit</td>
<td>1.8</td>
<td>9.7</td>
<td>0.0</td>
<td>4.0</td>
<td>2.2</td>
<td>4.7</td>
</tr>
<tr>
<td>Grass-cutter</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Socio-cultural</td>
<td>69.1</td>
<td>68.9</td>
<td>57.1</td>
<td>88.0</td>
<td>73.9</td>
<td>70.8</td>
</tr>
<tr>
<td>Festive events</td>
<td>62.7</td>
<td>61.2</td>
<td>50.0</td>
<td>76.0</td>
<td>54.3</td>
<td>61.4</td>
</tr>
<tr>
<td>Funeral ceremonies</td>
<td>38.2</td>
<td>46.6</td>
<td>42.9</td>
<td>32.0</td>
<td>63.0</td>
<td>44.6</td>
</tr>
<tr>
<td>Wedding expenses</td>
<td>6.4</td>
<td>12.6</td>
<td>7.1</td>
<td>16.0</td>
<td>6.5</td>
<td>9.4</td>
</tr>
</tbody>
</table>

CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, NM= No Microfinance.

5.5. Poultry-based interventions and rural households’ living conditions

5.5.1. Impact of poultry-based interventions on management skill and poultry income

Table 5.9 shows the effect of the various combinations of interventions on producers’ market-orientation (cf. section 5.3.1) and their gross margin from poultry production. This table indicates that the CBM without microfinance has a significant and positive impact (at 5% level) on participant households’ gross margin from poultry production, roughly FCFA 44,642 per year.

In the same way, the combination of CBM and microfinance has a significant and positive impact (at 5% level) on participants’ gross margin from poultry production. This impact is about FCFA 46,890 per year for those who participate in CBM and PBM, and FCFA 38,053 per year for the households which participated in CBM, but received non-poultry based microfinance.
When one takes microfinance alone (without the CBM), one notes that the participant households have a gross margin of FCFA 27,080 per year more than what they would have had if they had not participated in microfinance programs.

Please note that the ATET of the different treatments cannot be compared, because they are calculated for different treatment groups. Hence, strictly speaking, we cannot conclude, e.g., that CBM without microfinance is superior to CBM with NPBM. However, CBM used with or without microfinance seems to have a larger positive impact on participant households than using microfinance alone.

Concerning the market orientation logic; table 5.9 indicates that the impact of CBM and microfinance used separately, or in combination, has a positive and significant impact on the participant households. In other words, participation in CBM or a microfinance program or both increases the participant households’ entrepreneurship. Therefore, participant households have used the technologies and have improved their entrepreneurial behavior regarding poultry production in order to produce more for the market.

In short, CBM and microfinance used separately, or in combination, positively improve the participant households’ income from poultry production and helps them move from a subsistence-oriented logic towards an economic or market-oriented logic.

The positive and significant impacts of CBM and microfinance (alone or in combination) are certainly the result of the fact that these two programs have facilitated the adoption of village poultry improvement technologies amongst farmers. The training received through these two programs has also contributed to the accumulation of knowledge, which in turn increases poultry management skill among participants.

Table 5.9. Effects of poultry-based interventions on producers’ market orientation logic and gross margin

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Treatments</th>
<th>AVOM</th>
<th>ATET</th>
<th>BSE</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Treated</td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return over variable costs (g</td>
<td>CBM x PBM</td>
<td>90413.5</td>
<td>43523.4</td>
<td>46890.0</td>
<td>15587.5</td>
</tr>
<tr>
<td>gross margin) (FCFA/year)</td>
<td>CBM x NPBM</td>
<td>68267.7</td>
<td>30214.4</td>
<td>38053.3</td>
<td>17308.1</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>87716.1</td>
<td>43074.2</td>
<td>44641.8</td>
<td>19543.9</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>64468.7</td>
<td>37388.3</td>
<td>27080.4</td>
<td>10730.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>orientation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBM x PBM</td>
<td>0.641</td>
<td>0.450</td>
<td>0.190</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.538</td>
<td>0.277</td>
<td>0.262</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.654</td>
<td>0.329</td>
<td>0.325</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.493</td>
<td>0.321</td>
<td>0.172</td>
<td>0.075</td>
</tr>
</tbody>
</table>

AVOM = Average value of outcome after matching; ATET = Average Treatment Effect on Treated; BSE = Bootstrap standard error; NM= No Microfinance; CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance, *** Significant at 1%, ** Significant at 5%, * Significant at 10%
5.5.2. Impact of poultry-based interventions on poverty and vulnerability

Table 5.10 indicates that the CBM alone has a positive and significant (at 5% level) impact of FCFA 30,978 per capita on the participant households’ expenditure. In other words, households that participate in CBM experience an increase of FCFA 30,978 in expenditure per capita compared to what they would have experienced if they had not participated in CBM.

In the same way, the joint participation in CBM and PBM has a positive and significant impact of FCFA 32,213 per capita on participant households. For the CBM members who participated in non-poultry based microfinance (NPBM; microfinance that was not granted formally for poultry production), the impact of their joint participation in these programs on households’ expenditures is of a similar magnitude, as for the other groups of participants of CBM it is about FCFA 35,655 per capita per year.

For households who received microfinance alone without CBM, the impact (insignificant at 5% level) on households' expenditures is about FCFA 17,373 per capita per year. In other words, participation in microfinance alone did not significantly improve the participant households’ expenditure.

As stated in section 5.3.1, the incidence of income poverty is the proportion of the population living below the national income poverty line, i.e. below FCFA 109,400 per capita (INSAE, 2009). Table 5.10 clearly shows that joint participation in CBM and PBM significantly (at 1% level) reduces the incidence of poverty. It follows that expenditure (as a proxy for income) for almost a third (30.5%) of all households who participated both in CBM and in PBM is above the poverty line now, but would have been below the poverty line without the programs. Also, expenditure for more than a third (36.8%) of households that participated in CBM alone (without microfinance) is above the poverty line now, but would have been below the poverty line without the program. But, microfinance alone, or in combination with CBM, did not have a significant impact on the incidence of poverty.

Concerning the poverty gap (i.e. the difference between the expenses per capita of the household and the poverty line), table 5.10 indicates that CBM without microfinance and CBM with NPBM (non-poultry based microfinance) had a positive and significant impact on participant households (at 5% level). Put differently, the poverty gap among the participants in CBM and CBM-NPBM is estimated to be 0.24 units and 0.31 units, respectively, lower than it would be without the programs. This means that participation in CBM and CBM-NPBM has increased the income of the poorest participants so that they are not as far below the national poverty line, or are even above it. This result is corroborated by results of poverty severity. Indeed, the impact of CBM and CBM-NPBM on the severity of poverty (for participant households) is significant at 10% and 5% level respectively. In other words, the severity of poverty among participants in CBM and CBM-NPBM is estimated to be 0.20 units and 0.26 units, respectively, lower than the corresponding value for the same households if they had not participated in the programs.
Concerning the households’ vulnerability (table 5.11), only the joint utilization of CBM and PBM has a significant impact on participant households’ overall vulnerability. Households that participate in CBM and PBM experienced a reduction of their overall vulnerability of about 0.07 units compared to what they would have experienced if they had not participated in CBM and PBM. The other treatments, i.e. CBM alone or microfinance alone, do not significantly impact the participant households’ vulnerability.

When one observes different types of indicators involved in the overall vulnerability estimation, table 5.11 shows that no program (CBM with or without microfinance) has a significant impact on durable goods and shelter. This can be explained by the fact that shelter and durable goods are long term, e.g. things that are not replaced in the short term. In other words, the programs probably have no effect on these indicators in the short or medium term.

In contrast, the treatment CBM-PBM has significantly influenced the social and economic vulnerability of the participant households. In other words, participation in CBM and PBM has allowed the participant households to better feed their household members, to improve their
economic situation, compared to a hypothetical situation without CBM and PBM, and to gain more social status (organization and funding of traditional ceremonies or marriages).

The CMB alone (i.e. without the use of microfinance) also has a significant and positive impact on the economic vulnerability of participant households. Put differently, participation in CBM has allowed recipient households to better feed their household members and to gain more prosperity compared to a hypothetical situation without CBM and PBM. Since producers used to mainly sell their poultry when their granaries were empty and when they experienced unexpected events, one can say that participation in the CBM has allowed them to reduce their vulnerability, especially during this period of the year (especially through the purchase of food).

Table 5.11. Effects of poultry-based interventions on households’ vulnerability

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Treatments</th>
<th>AVOM</th>
<th>ATET</th>
<th>BSE</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Treated</td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material (durable goods)</td>
<td>CBM x PBM</td>
<td>0.318</td>
<td>0.325</td>
<td>-0.007</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.154</td>
<td>0.125</td>
<td>0.029</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.349</td>
<td>0.316</td>
<td>0.033</td>
<td>0.085</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.271</td>
<td>0.207</td>
<td>0.064</td>
<td>0.066</td>
</tr>
<tr>
<td>Shelter</td>
<td>CBM x PBM</td>
<td>0.547</td>
<td>0.478</td>
<td>0.069</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.298</td>
<td>0.389</td>
<td>-0.091</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.454</td>
<td>0.530</td>
<td>-0.076</td>
<td>0.063</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.433</td>
<td>0.463</td>
<td>-0.030</td>
<td>0.047</td>
</tr>
<tr>
<td>Economic</td>
<td>CBM x PBM</td>
<td>0.582</td>
<td>0.428</td>
<td>0.154</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.346</td>
<td>0.308</td>
<td>0.038</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>CBM x No microfinance</td>
<td>0.605</td>
<td>0.399</td>
<td>0.206</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.411</td>
<td>0.333</td>
<td>0.077</td>
<td>0.062</td>
</tr>
<tr>
<td>Social</td>
<td>CBM x PBM</td>
<td>0.356</td>
<td>0.155</td>
<td>0.201</td>
<td>0.079</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.154</td>
<td>0.205</td>
<td>-0.051</td>
<td>0.112</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.158</td>
<td>0.167</td>
<td>-0.009</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.285</td>
<td>0.171</td>
<td>0.114</td>
<td>0.071</td>
</tr>
<tr>
<td>Overall</td>
<td>CBM x PBM</td>
<td>0.442</td>
<td>0.372</td>
<td>0.071</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.233</td>
<td>0.257</td>
<td>-0.024</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.396</td>
<td>0.385</td>
<td>0.011</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.351</td>
<td>0.313</td>
<td>0.038</td>
<td>0.039</td>
</tr>
</tbody>
</table>

AVOM = Average value of outcome after matching; ATET = Average Treatment Effect on Treated; AV = Absolute value; BSE = Bootstrap standard error; NM= No Microfinance; CBM = Community-based management, PBM=Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

In short, CBM with or without microfinance has a positive impact on rural households’ wellbeing. Joint utilization of CBM and poultry-based microfinance is very effective at reducing the number of poor (positive and significant effect on the incidence of poverty). It follows that the joint utilization of CBM and microfinance has lifted mainly rural households who were
Chapter 5

closest to the poverty line out of poverty. However, the use of CBM alone (without microfinance) has not only reduced poverty incidence (significant at 10% level), but has also reduced the poverty gap and the severity of poverty. Therefore, technical support for village poultry farmers has substantially reduced poverty among the poorest households, while the addition of microfinance in particular, allows those farmers whose income was close to the poverty line to escape poverty. This finding is in agreement with the results of Shaw (2004) for whom microenterprise credit can work well for clients who are close to the poverty line.

The main information that arises from the above results is that the CBM positively and significantly improved the wellbeing of the participant households. This improvement is more significant when the participants in CBM receive poultry-based microfinance, i.e. microfinance for village poultry production. On the other hand, the use of microfinance alone (i.e. without CBM) does not improve the wellbeing of the recipient households. The second outcome is that the use of CBM (i.e. technical support for village poultry improvement) can only reduce poverty among the poorest households, but without the addition of poultry-based microfinance most of the participant households cannot escape poverty.

The results obtained above confirm that village poultry-based intervention is a tool for poverty reduction, especially among the poorest, but it only helps recipients to move out of poverty if the technical support through community-based management is coupled with poultry-based microfinance. These results are consistent with the findings of Islam and Jabbar (2005) who (using a before-after method with simple descriptive statistics) found that village poultry production, with all its limitations and potentials, may be used as a starting point to help the poor to diversify their activities as a pathway out of poverty, but that poultry alone may not be an adequate means in the long run for getting out of poverty for every poor household.

Finally, as the main targets of the poultry-based projects (analyzed in this study) are women, one can say that measures that increase women's income are more likely to positively affect family well-being than measures which increase men's incomes, because women tend to use a higher proportion of their earnings on children and household expenses, as previously stated by Hinze and Dawn (2007).

5.5.3. Impact of poultry-based interventions on gender empowerment and education

- Control over resources

The results in table 5.12 indicate that CBM combined with the PBM has a positive and significant impact (at 1% level) on women’s control of resources. In other words, women from the participant households (those who participated in CBM and PBM) experienced increased control over resources compared with what they would have experienced if they had not participated in the programs. The increase in gender empowerment regarding resources may be a result of the increase in their income from poultry. Indeed, as noted by Leach and Sitaram
(2002), men's general behavior towards women varied according to how much income they brought into the household. This suggests that income from poultry is an important factor in changing gender relations in favor of women.

Table 5.12. Effects of poultry-based interventions on gender empowerment and investments in children’s schooling

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Treatments</th>
<th>AVOM</th>
<th>ATET</th>
<th>BSE</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatments</td>
<td>Treated</td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women’s control over resources</td>
<td>CBM x PBM</td>
<td>0.463</td>
<td>0.240</td>
<td>0.223</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.629</td>
<td>0.550</td>
<td>0.079</td>
<td>0.169</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.395</td>
<td>0.355</td>
<td>0.039</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.400</td>
<td>0.433</td>
<td>-0.033</td>
<td>0.094</td>
</tr>
<tr>
<td>Children’s schooling</td>
<td>CBM x PBM</td>
<td>0.531</td>
<td>0.525</td>
<td>0.006</td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.762</td>
<td>0.746</td>
<td>0.016</td>
<td>0.164</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.538</td>
<td>0.620</td>
<td>-0.082</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.594</td>
<td>0.667</td>
<td>-0.073</td>
<td>0.096</td>
</tr>
<tr>
<td>Investment in children’s education</td>
<td>CBM x PBM</td>
<td>31925.6</td>
<td>26485.1</td>
<td>5440.4</td>
<td>13039.9</td>
</tr>
<tr>
<td>(FCFA)</td>
<td>CBM x NM</td>
<td>23653.2</td>
<td>29989.4</td>
<td>-6336.2</td>
<td>15373.3</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>42921.0</td>
<td>33185.9</td>
<td>9735.2</td>
<td>14577.2</td>
</tr>
<tr>
<td>Overall gender empowerment</td>
<td>CBM x PBM</td>
<td>0.495</td>
<td>0.375</td>
<td>0.120</td>
<td>0.063</td>
</tr>
<tr>
<td></td>
<td>CBM x NPBM</td>
<td>0.692</td>
<td>0.643</td>
<td>0.049</td>
<td>0.129</td>
</tr>
<tr>
<td></td>
<td>CBM x NM</td>
<td>0.463</td>
<td>0.481</td>
<td>-0.018</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>Non CBM x NPBM</td>
<td>0.492</td>
<td>0.544</td>
<td>-0.052</td>
<td>0.072</td>
</tr>
</tbody>
</table>

AVOM = Average value of outcome after matching; ATET = Average Treatment Effect on Treated; AV = Absolute value; BSE = Bootstrap standard error; NM = No Microfinance; CBM = Community-based management; PBM = Poultry-based microfinance, NPBM = Microfinance other than Poultry-based microfinance.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

- **Decision making regarding children’s schooling**

Regarding decision-making concerning children’s schooling, table 5.12 shows that joint participation in CBM and NPBM does not have a significant impact on women’s participation in decision-making regarding children’s schooling. Also, the use of CBM and microfinance separately does not have a significant effect on women’s participation in decision-making regarding children’s schooling.

These results are in contrast to the findings of Nielsen (1997) who states that recipients of poultry-based programs in Bangladesh gained greater influence on decision-making regarding children’s schooling. Also, Nielsen (1998) found that joint decision making regarding which children should be sent to school increased from 44% to 70%, whereas decision by women alone increased from 14% to 27% among recipients of the program. However, as Islam and Jabbar (2005) stated, although participation in the poultry project might have positively contributed to some of the indicators of enhanced women power, a clear attribution to the poultry-based
program is difficult due to the assessment method used (only descriptive statistics), and because of the presence of other programs in which recipients and non-recipients of poultry-based program have participated. These included a countrywide program on 'food for education' through which food was given to children in order to encourage poor families to school their children (Islam and Jabbar, 2005).

- **Investment in children’s schooling**

  Participation in CBM or microfinance program or both does not have a significant effect on the participant household’s investment in children’s schooling. In fact, the non-significant effect of CBM and microfinance on education can be explained by the fact that these programs are mainly awarded to women. These women have relatively weak decision-making power concerning children’s schooling in rural areas of Benin. In Benin, in general, the decision concerning children’s schooling is made by the father, who is usually the one who pays the school fees and other related expenses.

- **Overall gender empowerment**

  Table 5.12 indicates that only the joint participation in CBM and PBM has a positive and significant effect on overall gender empowerment. The other treatments (CBM, NPBM and the combination of CBM-NPBM) have negative, but no significant, effects on overall gender empowerment.

  Besides, the surveyed households were asked whether implementation of poultry-based projects had had an effect on women’s involvement in decision-making in their households. About 70% of the participant households said that it had improved women’s involvement in decision-making in their households. About 30% of the participants thought that participation in poultry-based programs had not changed women's role in decision making in the household. The majority of participants thought that involvement in the poultry-based programs improved the participation of women in decision-making in their households.

5.6. **Conclusion and implications**

The objective of this chapter was to assess the impact of poultry-based interventions (namely community-based management and CBM and poultry-based microfinance) on rural households’ living conditions. For this purpose, we used a non-parametric impact assessment approach: the propensity score matching. The main result of the analysis is that the community-based management positively and significantly improved the wellbeing of the participant households: higher income from poultry production, improved skill/market orientation logic, reduction of poverty and poverty gap and gender control over resources. This improvement is more significant when the participants in CBM receive poultry-based microfinance, i.e. microfinance
for village poultry production. On the other hand, the use of microfinance alone (i.e. without CBM) did not improve the wellbeing of the recipient households.

Finally, our results confirm the fact that village poultry is a tool for poverty reduction especially among the poorest. However, this only helps recipients to move out of poverty if technical support through community-based management is combined with poultry-oriented microfinance. Technical support for village poultry has the power to not only significantly reduce the incidence of poverty, but also the poverty gap and severity of poverty. The addition of microfinance allowed farmers, whose income was close to the poverty line, to escape from poverty. In other words, village poultry production may be used as a starting point to help the poor to make the first step out of poverty, but on its own, it may be inadequate for lifting every poor household out of poverty.
6.1. **Introduction**

The previous chapters were concerned with the impact of poultry-based intervention on poultry production performance and on rural households’ living conditions. However, innovations alone are insufficient to trigger smallholder income growth; sustained income growth at the farm level depends also on access to final markets further up the supply chain (Chitundu et al., 2009). In fact, access to markets can be an incentive to improve poultry farming management and increase its performance, whilst it is also important in stimulating the production and consumption of village poultry products. For small-scale village poultry producers, marketing opportunities are crucial for gaining from improved technologies by generating cash income. The aim of this chapter is to assess village poultry market performance and how this market works for the poor village poultry producer, the way their positions could be improved, and how changes in market performance would affect them. For this purpose, data were collected in rural as well as urban markets. These data were analyzed using the structure-conduct-performance (SCP) model and the hedonic price model (section 6.2). The village poultry market structures are described in section 6.3. This is followed by section 6.4 in which the conduct (or behavior) of different marketing agents is analyzed. Section 6.5 deals with village poultry marketing performance, analyzing price movement over time and space, village poultry transaction costs and traders’ marketing margin. Trader’s preferences for village poultry characteristics are assessed in section 6.6. The last section of this chapter concludes.

6.2. **Methodology**

6.2.1. **Theoretical framework**

Following Fu (2003), the term ‘performance’ as used by Industrial Organization (IO) economists generally refers to the degree to which the operation of a market can achieve economic efficiency. For this author, a market is more efficiently operated when the goods transacted in it are manufactured by transforming resources more thriftily and are then allocated to agents who have higher valuations. Herein, performance, first and foremost, refers to a ‘market’ as a whole, which comprises all the interacting buyers and sellers, instead of individual economic agents such as firms (Fu, 2003).

There are several methods that can be used to assess market performance such as the structure-conduct-performance (SCP) paradigm, transaction cost analysis, marketing margins analysis,
Analysis of the performance of village poultry market

supply and demand relations analysis, and explanation for price movements over time and space. Following Bos (2004), no agreement exists as to what measure is superior. The existence of a wide range of models suggests that there is hardly any single, truly adequate theoretical framework for studying markets, particularly in developing countries (Williams et al., 2006). Accordingly, this study used a combination of approaches including SCP paradigm, marketing margin analysis, and explanation for price movements (over time, space and products characteristics).

6.2.1.1. Structure-conduct-performance paradigm

Following Bos (2004), the structure-conduct-performance (SCP) model (figure 6.1) has the potential to capture any type and size of market power, as long as it affects performance through market structure. It constitutes three elements, namely the market structure, the conduct (or behavior), and the market performance.

The structure is concerned with the characteristics of the market, which seem to strategically influence the nature of competition and pricing within the market. These characteristics include the number of buyers and sellers, barriers to entry of new firms, product differentiation, vertical integration, and diversification. The structure of perfect competition is one, where firms are sufficiently numerous and of such sizes that no single firm, or several firms in combination, can influence outcomes, products are homogenous or standardized, and entry is easy (Farris, 1997).

The market conduct refers to the behavioral rules followed by buyers, sellers, and potential entrants to choose the variables under their control. It refers to various strategies adopted by participants in buying, selling, and pricing. The most important parameters used in assessing market conduct are: advertising, pricing behavior, legal tactics, product choice, collusion, merger and contracts. The conduct of the market depends on its structure.

The performance of a market or industry’s performance (the success of an industry in producing benefits for consumers) depends on the conduct (behavior) of its firms, which, in turn, depends on the structure (factors that determine the competitiveness of the market) (Carlton and Perloff, 2000). However, Carlton and Perloff (2000) note that, the empirical relationship between measures of performance, such as price-cost margins, and market structure, such as concentration and entry barriers, is unclear. Following Farris (1997), faulty performance or market failure may be have many causes, including imperfect information, high transaction costs, lags in adjustment to change, inadequate infrastructure, monopolistic elements, or other impediments, such as some government policies and interventions undertaken to achieve diverse goals. Market performance includes profits or price-cost margins, market efficiency, sales-promotion costs, product characteristics, and technological progress (Farris, 1997). Understanding how the performance of the market is affected by the structure through the behavior of actors in the market can provide a basis for identifying opportunities to be exploited and constraints that need to be removed.
Structure and conduct can be measured directly while performance is generally assessed indirectly. Following Williams et al. (2006), the quality of results from the direct measurement of the structure and conduct of a market could be enhanced when, for example, (as in this study) marketing channels are separated spatially and the traders operating within these channels have been stratified according to the scale of their operation and their roles and functions in the marketing chain. These authors claim that the existence of these strata implies that a certain degree of price collusion could go on within and between strata that may affect market entry conditions and result in changes in market structure.
Finally, there is a need to note that the SCP paradigm suffers from some limitations, in particular the employment of static analysis focused on equilibrium conditions and the assumption of homogeneity of firms within the industry (McWilliams and Smart, 1993). Despite these shortcomings, the SCP paradigm is still being used in a number of agricultural marketing studies.

6.2.1.2. Marketing margins analysis

There are two ways of defining marketing margins, which are also referred to as vertical 'price-spreads' or 'mark-ups' (Briz and de Felipe, 1997). The first is the price difference between different marketing stages (e.g. consumer, wholesale, processor, or farmer). The second is the cost of the services provided along the marketing channel. In this case, it refers to the part of the consumer’s food expenditure, which is absorbed by the food marketing sector. Various marketing margins are available in the literature such as absolute marketing margin (AMM), relative marketing margin (RMM), gross marketing margin (GMM) and net marketing margin (NMM).

The Absolute marketing margin is the gap between prices at different marketing level (farmers, wholesalers, retailers). Thus, $M_{FR} = P_R - P_F$; $M_{WR} = P_R - P_W$; $M_{FW} = P_W - P_F$; where $M_{FR}$, $M_{WR}$ and $M_{WF}$ are Absolute Marketing Margins (AMM) at different levels, and $P_F$, $P_W$, $P_R$ are prices at farmer, wholesale and retail level respectively.

The relative marketing margin can be defined as:

$$RMM = M / P_S$$

where $P_S$ is the price paid by the trader when he/she purchases the product and $M$ the absolute marketing margins. For instance, $RMM$ from the farmer to retailer will be $RMM_{FR} = M_{FR} / P_R$ in percentage terms.

The gross marketing margin is obtained by multiplying the AMM by the quantity sold ($Q_0$); assuming the quantity is similar at both price levels (upper and lower levels). In marketing activities, many enterprises use this concept. Formally, the $GMM$ is defined as:

$$GMM = Q_0M,$$

The net marketing margin takes account of fixed costs ($FC$), taxes ($T$), variables costs ($Va$) and subsidies ($S$). It is given by:

$$NMM = GMM - FC - T - Va + S.$$   

6.2.1.3. Transactions costs approach

The transaction cost approach regards the transaction as the basic unit of analysis; it says that the study of organizations requires an understanding of transactions cost (Williamson, 1981). This
author argues that the transaction cost approach to the study of the market has been applied at three levels of the analysis. The first is the overall structure of the enterprise, which takes the scope of the enterprise as given and asks how the operating parts should be related one to another. Unitary, holding company, and multidivisional forms come under scrutiny when these issues are addressed. The second, or middle level, focuses on the operating parts and asks which activities should be performed within the firm, which outside it, and why. This can be thought of as developing the criteria for and defining the “efficient boundaries” of an operating unit. The third level of analysis is concerned with the manner in which human assets are organized. The object here is to match internal governance structures with the attributes of work groups in a discriminating way.

Transactions costs include many elements, such as the costs of searching for partners with whom to trade, screening potential trading partners to ascertain their trustworthiness, and bargaining with these partners to reach an agreement (Staal et al., 1997). Transaction costs also include the cost of transferring the product (e.g. transportation, processing, packaging, and securing title), the cost of monitoring the agreement to see whether its conditions are fulfilled, and enforcing (or seeking damages for any violation of) the exchange agreement (Staal et al., 1997).

6.2.1.4. Analysis of price movements over time and space

The prices of agricultural products can be observed at different levels in the marketing system such as farm, wholesale or retail levels. These prices may be recorded and reported daily, weekly, monthly, annually, etc. They are an important determinant of the level of farm income, the cost of food to consumers, export income for countries engaged in commodity trade, the profits for agricultural marketing firms and returns to commodity traders and speculators (Carman, 1997). The movement of these prices can be assessed over time, space, and according to the good’s quality.

- **Analysis of price variation over time (seasonal movement)**

The seasonal price movements are always due to regular seasonal changes in supply and demand that are repeated each 12 months. The analysis of these movements can be based on simple graphics, on prices indexes, or on regression analysis (Carman, 1997). Following Carman (1997), an index of seasonal price changes is probably the easiest way in which to view average prices over the year. Using this approach, an average over several periods (i.e. over 12 months) is the base value (index value of 100). Dividing each weekly or monthly price by the base value provides a measure of the seasonal price variability.

- **Spatial price analysis**

The main purpose of spatial price analysis is to appreciate the level of integration between markets located in different geographical areas. This is very important in less developed countries like Benin, where measuring spatial price linkages between commodity markets has
received much attention in the literature because of its implications for the functioning of food markets (Dawson and Dey, 2002). These authors note that two empirical issues have dominated the literature on spatial market integration: first, whether or not markets are integrated and second, the direction of causality between markets and whether one market dominates another.

Baulch et al. (2008) argue that tests of spatial market integration using time-series data on food prices date back to the 1960s. Indeed, the first tests arose from Lele’s (1967) analyses of the integration of sorghum market in Western India. He used correlation coefficients between weekly wholesale prices to assess the level of integration. When the correlations were greater than 0.7 or 0.8, he concluded that price movements were close enough for the two markets to be considered as being spatially integrated. Under conditions of perfect competition, the correlation between price movements of a commodity in any two markets will be perfect, i.e. 1.00 (Lele, 1967). The degree of correlation will, however, be less than perfect in any real-world situation. In other words, the assumption of perfect mobility is not fulfilled in the real world because of transport costs.

Following Baulch et al. (2008), the cut-off point used by Lele (1967) for deciding whether markets are spatially integrated was arbitrary and no consideration was given to whether the price series were stationary or non-stationary. Also, the amount of information correlation coefficients can provide is limited (Alexander and Wyeth, 1994). For these reasons, various alternative econometric approaches have been developed, e.g. dynamic regression models such as Ravallion model (cf. Ravallion, 1986) and cointegration analysis (cf. Fackler and Goodwin, 2001). These methods will not be described in this study since we cannot apply them due to an insufficient number of observations in our data set.

### 6.2.1.5 Analysis of price variation according to product’s characteristics

In the above paragraphs, it is assumed that the products are homogeneous, which is one of the criteria for perfect competition. However, a good can vary according to certain specific characteristics on which the consumer often bases his/her decision. For example, chicken can vary according to race, sex, plumage, taste, etc. Thus, a traditional chicken is not the same as an improved chicken. In the same way (in Benin), a chicken with a white color is not the same as one with a black or red color. In short, each commodity is a bundle of characteristics. In other words, in Becker’s (1965) consumer theories, consumers have preferences for the characteristics of commodities. Provision of information on consumer preferences can allow producers and traders to improve their earnings from livestock sales (Williams et al., 2006).

The statistical method available for the analysis of price variation over characteristics is the **hedonic price** analysis. Its subjacent assumption postulates that each good is characterized by a set of characteristics. Stated differently, the hedonic prices are based on the hypothesis that goods are valued for their utility-bearing attributes (Rosen, 1974). Thus, hedonic prices are the implicit prices of various attributes embodied in a commodity and the price of the commodity is
a function of the amounts of the attributes it contains and the values placed on these attributes (Carman, 1997). There is no \textit{a priori} rule about the inclusion of quality characteristics in the model, but the characteristics included should be observable and economically relevant to the buyers (Orden et al., 2005).

In practice, the empirical approach commonly used to estimate the hedonic price is based on a regression model. For a given good, the hedonic relationship or hedonic regression can be written:

\[ p = f(x) \] (6.4)

where \( x = (x_1, \ldots, x_k)' \) is the set (vector) of characteristics for the good, and \( p \) its price. The implicit or hedonic prices are the partial derivatives of the hedonic function (5.7):

\[ \frac{\partial p}{\partial x_k}(x) = \frac{\partial f}{\partial x_k}(x) \text{ with } k = 1, \ldots, K \] (6.5)

The hedonic price \( \partial f / \partial x_k(x) \) indicates how much the price \( p \) of a good (roughly) changes if the good is, \textit{ceteris paribus}, endowed with an additional unit of the characteristic \( x_k \) (Brachinger, 2002). In other words, it reveals the marginal bid of consumers for every change in the underlying physical quality characteristics of the good.

Estimation of the economic value of a particular characteristic can have several uses in the agricultural sector. It can help the researcher or producer to better orient his/her work in order to develop and produce products (for example varieties, races of animals, etc.) in order to fulfill the requirements of the market and those of the consumer. Producers may be able to alter their production practices, use of inputs, or varieties to influence attributes that increase product prices (Carman, 1997). The traders, or middlemen, will also be able to adopt strategies for transport, handling, storage and transformation in order to improve retail level product prices through an emphasis on attributes important to end users.

### 6.2.2. Analytical framework

Data used in this study were gathered on chicken, duck and guinea-fowl traders through two main steps. The first step involved an exploratory survey during which the major players in the village poultry market were identified, namely livestock-keepers, assemblers, commissionaire agents, rural wholesalers, urban wholesalers, retailers and others (transporters, processors, etc.). This step also facilitated the identification of various attributes that could influence the village poultry price. These characteristics included the breed of the bird, its weight, sex, color of plumage, size (height on leg), meatiness, age, and others. The second step was concerned with personal interviews in five rural and four urban markets, mainly with village poultry traders, using structured questionnaires (cf. details in section 2.1.2).
Structure-conduct-performance (SCP), transaction costs, marketing margins as well as price movement over time and between markets were analyzed to assess the village poultry market performance. In addition to these methods, hedonic regression was used to analysis price differences between animals with different characteristics, i.e. traders’ preferences for poultry characteristics.

The SCP approach as used in this study included the structure, the conduct or behavior of the traders, and the performance. The main components of the structure were the location of producer sale, the type of markets, different marketing agents (their characteristics, financial power and dynamic), village poultry products distribution channel, traders’ organization, and entry barriers.

The assessment of the trader’s behavior was mainly based on the analysis of their sale price setting strategies and the information sharing and traders’ marketing strategies. The analyses of the conduct as well as the structure of the market were mainly descriptive.

The village poultry market performance assessment was carried out through an analysis of the movement of prices over time and between markets, market integration, product transaction costs structure and traders’ marketing margin.

The analysis of the movement of prices over time is based on simple graphics. These graphics were based on poultry prices collected during the survey. Indeed, no data on poultry products were officially recorded by the governmental institutions in rural markets. In the urban markets of Cotonou, the National Institute for Statistics (INSAE) used to record data on chickens only, but not ducks and guinea-fowl. Thus, we focused our analysis on bimonthly data collected at rural and urban markets between May 2008 and April 2009. For rural markets, prices paid by traders when they buy poultry products (what is roughly equivalent to the selling price of producers) were used to make figures. For the urban markets, it was the selling prices of traders which were used to make figures, which roughly corresponds (in urban markets) to consumers’ purchase prices because our observations include market fees.

Market integration was gauged using bivariate correlation coefficients. When the correlations were greater than 0.8, we concluded that price movements were close enough for the two markets to be considered as being spatially integrated. However, as stated in section 6.2.1, correlation coefficients are not the best method to study market integration. But, in this study, the data available were not sufficient to use more suitable methods such as cointegration analysis or the Ravallion model.

Village poultry transaction costs, as used in this study, represent the total observed costs of moving the bird from one market to another, including the transport costs, taxes, handling costs ( levy, watchman), storage costs, depreciation of equipment used, and others (feeding of the birds...
after purchase and before selling, incidentals, etc.). It is relevant to note that the cost of the trader’s own labor was not included in the transaction costs.

The marketing margins calculated were the absolute marketing margin (AMM), the relative marketing margin (RMM), the gross marketing margin (GMM) and the net marketing margin (NMM). The formulas used are described in section 6.2.1 (equation 6.1 to 6.3).

Price variation through product’s quality or characteristics was analyzed at traders’ level. Indeed, traders’ preferences are like a proxy to assess the consumers’ preferences: we have a primary demand at the retail level and derived demands at the wholesale and farmer levels. In practice, the exponential functional form was used to estimate the relationship between price and bird attributes. The model is described by:

\[ p = \beta_0 \prod_{k=1}^{K} \exp(\beta_k x_k) \quad \text{or} \quad \ln p = \ln \beta_0 + \sum_{k=1}^{K} \beta_k x_k \]  

(6.6)

where \( p \) is the price of the live bird in FCFA, and \( x_k \) are the bird’s attributes. Nine attributes are used in the hedonic regression for chickens (table 6.1). But, for ducks and guinea fowl, variables \( x_1 \) (breed) and \( x_9 \) (age less than 6 months) were not used. Indeed, during the qualitative survey, we found that only indigenous breeds for duck and guinea fowl where available on the market.

Furthermore, it is possible for the elasticity of the poultry price with respect to a given attribute to depend upon the magnitude of yet another attribute. For example, the elasticity of the chicken price, with respect to its weight, might depend on its sex. To test this type of assumption, two interactions were introduced in the hedonic price model. For chickens, equation 6.6 can be rewritten:

\[ \ln p = \ln \beta_0 + \sum_{k=1}^{K} \beta_k x_k + \gamma_{16} x_1 x_6 + \gamma_{36} x_3 x_6 \]  

(6.7)

For ducks and guinea fowl, only the interaction between the sex and the weight was introduced in the model since the variable \( x_1 \) (i.e. breed) was not taken into account for these birds. Thus, equation 6.6 can be rewritten:

\[ \ln p = \ln \beta_0 + \sum_{k=1}^{K} \beta_k x_k + \gamma_{36} x_3 x_6 \]  

(6.8)

The hedonic prices are summarized in the third column of table 6.1. The ordinary least-squares regression (OLS) was used to estimate the functions of equation 6.7 and 6.8.
Table 6.1. Variables used in the hedonic regression along with hedonic prices equations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Label</th>
<th>Hedonic prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>Breed (1 = indigenous, 0 = crossbreed)</td>
<td>$\frac{\partial p}{\partial x_1} = (\beta_1 + \gamma_{x_1} x_1) p$</td>
</tr>
<tr>
<td>$x_2$</td>
<td>Height on leg (0 = short, 1 = long)</td>
<td>$\frac{\partial p}{\partial x_2} = \beta_2 p$</td>
</tr>
<tr>
<td>$x_3$</td>
<td>Sex of the bird (1 = male, 0 = female)</td>
<td>$\frac{\partial p}{\partial x_3} = (\beta_3 + \gamma_{x_3} x_3) p$</td>
</tr>
<tr>
<td>$x_4$</td>
<td>Color white of the plumage (1 = white, 0 = otherwise)</td>
<td>$\frac{\partial p}{\partial x_4} = \beta_4 p$</td>
</tr>
<tr>
<td>$x_5$</td>
<td>Color black of the plumage (1 = black, 0 = otherwise)</td>
<td>$\frac{\partial p}{\partial x_5} = \beta_5 p$</td>
</tr>
<tr>
<td>$x_6$</td>
<td>Weight (in kg)</td>
<td>$\frac{\partial p}{\partial x_6} = (\beta_6 + \gamma_{x_6} x_6) p$</td>
</tr>
<tr>
<td>$x_7$</td>
<td>Meatiness (1= highly meaty, 0 = otherwise)</td>
<td>$\frac{\partial p}{\partial x_7} = \beta_7 p$</td>
</tr>
<tr>
<td>$x_8$</td>
<td>Age of the bird (1 = between 6 and 12 months, 0 = otherwise)</td>
<td>$\frac{\partial p}{\partial x_8} = \beta_8 p$</td>
</tr>
<tr>
<td>$x_9$</td>
<td>Age of the bird (1 = less than 6 months, 0 = otherwise)</td>
<td>$\frac{\partial p}{\partial x_9} = \beta_9 p$</td>
</tr>
</tbody>
</table>

6.3. **Structure of the village poultry market**

6.3.1. **Location of producers sales and different markets**

➤ **Location of producers sales**

There are three main places where the surveyed producers used to sell their poultry products, namely at home, at the local market or by the roadside. Selling at home concerns about 8% of interviewees. In this case, the products are sold to traders (assemblers and commission agents), to farmers for breeding purposes, or to people who want to make a sacrifice. Assemblers and commission agents used to go to farms to purchase poultry products notably when the demand was high on the market, or when they needed live poultry with specific characteristics (e.g. white, red or black color), or when they lent money to the producer in order to guarantee poultry products. In general, products sold at home are more expensive than those sold at the local market and mainly concern parents, eggs for breeding, live birds used in traditional ceremony or for sacrifices.

Around 92% of the producers used to sell their products at local markets or by roadsides. In the North, producers have to pay a municipal tax (FCFA 50 for each live bird sold) at the market, whereas in the South they pay nothing. In the South, men and women can take their poultry products to the market, contrary to the North, where it is only the husband who is in charge of
the sale of poultry products. Indeed, in the research villages of the North, farmers state that, according to tradition, women are not allowed to take poultry to market.

By roadsides, farmers sold poultry products to assemblers and to commissionaire agents who work for urban wholesalers. Following Sodjinou and Koudande (2008), sales by the roadside allow producers to escape from municipal taxes, but prices, in this case, mainly benefit traders. However, when the producer believes that the price offered by assemblers (who stay on the roadsides) is very low, he takes his goods to the market place.

In general, very few producers take their products to urban markets. This mainly concerns producers who have motorized means. This result matches those obtained by Omiti et al. (2009) in Kenya where they found that only a small proportion of the total output is taken to the more lucrative (but distant) urban markets. As they state, these farmers do not participate effectively in the urban markets, which offer excellent opportunities for increasing their farm incomes and allowing them to escape poverty.

Different village poultry markets

Village poultry markets can be divided into three categories (table 6.2): rural or primary markets, secondary or regional markets and urban markets. Rural markets (e.g. Avakpa, Doutou, Lobogo and Kolokonde) are those situated in or near the production sites and they constitute the main selling place for farmers. However, access to these markets is difficult for traders from urban areas, notably due to the bad quality of the roads especially during the rainy season. The main buyers at this type of market are assemblers and rural wholesalers. Poultry product transactions take place in the sun, under trees or under shelters made of wood with roofs of straw or in the branches of palm trees. Often, very few urban consumers (especially tourists) visit these markets. In rural markets of the North, trade in poultry products often takes place in the morning between 9:30 and 14:00, whilst in the South, trade in poultry products mainly occurs in the afternoon roughly from 15:00 to 19:30.

Regional markets (e.g. Kassua, djougou) are situated in small towns and these represent a meeting place where poultry products are sold to urban wholesalers of Cotonou, Porto-Nov, Parakou, etc. The main sellers at this type of market are assemblers, rural wholesalers and producers, mainly those who have motorized transport. Buyers constitute urban wholesalers, some restaurant owners, and a few consumers mainly from small urban areas and tourists. Kassua market also receives traders and farmers from Togo Republic, who used to trade turkey and guinea-fowl.

Urban or consumption markets (Dantokpa, Ouando and Arzeke) are situated in large cities such as Cotonou, Porto-Nov and Parakou. Practically no producer visits this type of market. The main sellers constitute retailers and urban wholesalers. Buyers are consumers, restaurants and
Analysis of the performance of village poultry market

others (roaster, etc.). In urban markets, poultry products are available everyday roughly from 9:00 to 18:00.

Finally, it is important to note that the Dantokpa and Avakpa markets (in the South), Kolokondé and Djougou (in the North) take place every 4 days. Ouando takes place every two days, whereas the Kassua market takes place every Tuesday.

Table 6.2. Main types of village poultry market in the surveyed areas

<table>
<thead>
<tr>
<th>Type of market</th>
<th>Description</th>
</tr>
</thead>
</table>
| Rural market  | - Located in production/rural area  
- Main sellers are farmers  
- More accessible to producers  
- Less used by urban consumer  
- Main buyers are assemblers and rural wholesalers  
- Less equipped |
| Regional markets | - Urban wholesalers are main buyers  
- Main sellers are assemblers, rural wholesalers and farmers having motorized transport  
- Used by certain producers  
- Better equipped than rural markets |
| Urban markets  | - Situated in big cities  
- Highly used by urban consumers  
- Main sellers are retailers and wholesalers  
- No producer takes his products to this type of market |

6.3.2. Description of different marketing agents

Assemblers, commissionaire agents, rural wholesalers, urban wholesalers and retailers are the main agents identified in the village poultry marketing system. Table 6.3 shows that all these traders sell chicken, apart from retailers in the South where 20% do not sell chicken. Roughly 55% of the traders interviewed also sell chicken eggs and 68% sell ducks. Guinea-fowl and its eggs are sold by around 82% and 53% of agents respectively.

Assemblers are, in general, the first link between producers and other middlemen. They do not have a fixed place on the market and usually stay by the roadside (just at the entry of the market place). The objective of staying here is to intercept poultry producers who come to the market. After buying poultry products from producers, they sell them to rural wholesalers who have fixed places.

In the North, assemblers are mainly men aged 40 years old on average with 14 years of experience in village poultry trade (table 6.4). On the other hand, in the South, 91% of assemblers are women aged 41 years on average with 14 years of experience in village poultry trade. The difference between the two regions can be explained by the fact that the North is dominated by the Muslim religion, whereas the South is more Christian. About 26% of the assemblers in the South received a formal education, whereas in the North, this proportion is
roughly 38%. Also, 61% of assemblers in the South and 75% of those in the North started their activity on their own initiative (table 6.5), with an average initial capital of FCFA 15,403. Roughly 61% of assemblers trade 100 to 500 chickens per month and up to 50 ducks (table 6.6). About 48% of them trade 100 to 500 guinea fowls and 45% market 100 to 500 guinea fowl eggs.

<table>
<thead>
<tr>
<th>Region</th>
<th>Agents</th>
<th>Chicken</th>
<th>Chicken eggs</th>
<th>Duck</th>
<th>Guinea-fowl</th>
<th>Guinea-fowl eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Assembler (n=23)</td>
<td>100.0</td>
<td>43.5</td>
<td>69.6</td>
<td>82.6</td>
<td>56.5</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>100.0</td>
<td>60.0</td>
<td>100.0</td>
<td>100.0</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=21)</td>
<td>100.0</td>
<td>81.0</td>
<td>38.1</td>
<td>76.2</td>
<td>66.7</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=20)</td>
<td>80.0</td>
<td>50.0</td>
<td>55.0</td>
<td>65.0</td>
<td>55.0</td>
</tr>
<tr>
<td></td>
<td>All (n=70)</td>
<td>94.3</td>
<td>58.0</td>
<td>58.0</td>
<td>76.8</td>
<td>60.9</td>
</tr>
<tr>
<td>North</td>
<td>Assembler (n=8)</td>
<td>100.0</td>
<td>12.5</td>
<td>75.0</td>
<td>75.0</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>100.0</td>
<td>16.7</td>
<td>83.3</td>
<td>100.0</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=14)</td>
<td>100.0</td>
<td>85.7</td>
<td>100.0</td>
<td>85.7</td>
<td>78.6</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=29)</td>
<td>100.0</td>
<td>51.7</td>
<td>72.4</td>
<td>89.7</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
<td>All (n=57)</td>
<td>100.0</td>
<td>50.9</td>
<td>80.7</td>
<td>87.7</td>
<td>43.9</td>
</tr>
<tr>
<td>All regions</td>
<td>Assembler (n=31)</td>
<td>100.0</td>
<td>35.5</td>
<td>71.0</td>
<td>80.6</td>
<td>45.2</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>100.0</td>
<td>36.4</td>
<td>90.9</td>
<td>100.0</td>
<td>63.6</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>100.0</td>
<td>82.9</td>
<td>62.9</td>
<td>80.0</td>
<td>71.4</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>91.8</td>
<td>51.0</td>
<td>65.3</td>
<td>79.6</td>
<td>42.9</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>96.8</td>
<td>54.8</td>
<td>68.3</td>
<td>81.7</td>
<td>53.2</td>
</tr>
</tbody>
</table>

Commissionaire agents are often married women whose role is to help the urban wholesalers in the purchase of poultry products from farmers. Assemblers, as well as commissionaire agents, operate in rural areas, but the difference between them is that the former have their own capital, whereas the latter do not have their own capital and work for urban wholesalers\(^{37}\). Roughly 20% of poultry products bought by urban wholesalers pass through these agents. Normally, they receive FCFA 50 to FCFA 100 for each bird (chicken, duck or guinea-fowl) purchased. But, in reality, these agents receive the great part of their profit from the difference between the price mentioned to the urban wholesalers and the real price paid to the producer. This difference depends upon the bargaining skills of the commissionaire agent.

Rural wholesalers constitute men as well women whose education level is a bit better than the assemblers. The difference between rural wholesalers and assemblers is that rural wholesalers have less contact with producers. Rural wholesalers often have fixed stalls in the market, which is in contrast to the assemblers. In the same way, rural wholesalers have more initial capital (on average FCFA 33,333) and are better equipped than assemblers. Around 58% of them started

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\(^{37}\) For this reason, the profitability of the commissionaire agents was not calculated in section 5.5 since the amount of money that they receive is already included in the transaction costs of urban wholesalers.

Also, it is relevant to note that commissionaire agents were only interviewed during the focus group and informal discussion.
their activity on their own initiative and have 14 years of experience in the village poultry trade. Also, 55% of the rural wholesalers trade more than 500 chickens and/or 100 to 500 guinea fowl per month. Approximately 91% of them sell more than 100 guinea fowl eggs per month and 36% of them sell between 100 and 500 ducks per month (table 6.6).

Table 6.4. Characteristics of village poultry traders

<table>
<thead>
<tr>
<th>Region</th>
<th>Type of trader</th>
<th>Sex of the trader (%)</th>
<th>Education (%)</th>
<th>Age of the trader (year)</th>
<th>Experience in poultry trade (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>Assembler (n=23)</td>
<td>91.3</td>
<td>8.7</td>
<td>26.1</td>
<td>41.2 (9.5)</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>100.0</td>
<td>0.0</td>
<td>33.3</td>
<td>39.2 (5.8)</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=21)</td>
<td>90.5</td>
<td>9.5</td>
<td>14.3</td>
<td>44.3 (8.9)</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=20)</td>
<td>75.0</td>
<td>25.0</td>
<td>15.0</td>
<td>44.3 (9.6)</td>
</tr>
<tr>
<td></td>
<td>All (n=70)</td>
<td>87.1</td>
<td>12.9</td>
<td>20.0</td>
<td>42.8 (9.1)</td>
</tr>
<tr>
<td>North</td>
<td>Assembler (n=8)</td>
<td>0.0</td>
<td>100.0</td>
<td>37.5</td>
<td>39.5 (9.8)</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>16.7</td>
<td>83.3</td>
<td>50.0</td>
<td>38.7 (10.9)</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=14)</td>
<td>14.3</td>
<td>85.7</td>
<td>35.7</td>
<td>44.4 (10.3)</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=29)</td>
<td>44.8</td>
<td>55.2</td>
<td>41.4</td>
<td>38.9 (9.3)</td>
</tr>
<tr>
<td></td>
<td>All (n=57)</td>
<td>28.1</td>
<td>71.9</td>
<td>40.4</td>
<td>40.3 (9.8)</td>
</tr>
<tr>
<td>All regions</td>
<td>Assembler (n=31)</td>
<td>67.7</td>
<td>32.3</td>
<td>29.0</td>
<td>40.7 (9.5)</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>58.3</td>
<td>41.7</td>
<td>41.7</td>
<td>38.9 (8.4)</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>60.0</td>
<td>40.0</td>
<td>22.9</td>
<td>44.4 (9.3)</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>57.1</td>
<td>42.9</td>
<td>30.6</td>
<td>41.1 (9.7)</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>60.6</td>
<td>39.4</td>
<td>29.1</td>
<td>41.7 (9.5)</td>
</tr>
</tbody>
</table>

( ): Standard deviation

Urban wholesalers are from large cities such as Cotonou, Porto-Novo and Parakou. They have more financial means than the other poultry traders and started their activities with an average initial capital of FCFA 75,743. Urban wholesalers are mainly women: 91% in the South and 86% in the North. 90% of urban wholesalers have trade as main activity, 89% of them sell more than 500 chickens per month and 54% of them sell more than 500 chicken eggs. About 34% and 37% of them sell 100 to 500 ducks and guinea fowl respectively. At urban markets, urban wholesalers resell products to retailers, consumers and restaurants owners. Sales of poultry products occurred not only at the market place, but also at the traders’ home.

Retailers are situated in big cities and have on average 17 years of experience in village poultry trade in the North and 20 years in the South. They can be categorized into two groups: those who have a fixed place at a public market or at home, and those without a fixed place who sell their products from door to door. Retailers generally buy from urban wholesalers and resell products in urban markets, mainly to urban consumers. Roughly 61% of retailers trade 100 to 500 chickens per month, 47% of them trade 100 to 500 chicken eggs per month and 84% of them trade less than 100 guinea fowls per month.
Table 6.5. Entry in poultry products marketing and traders’ financial means

<table>
<thead>
<tr>
<th>Region</th>
<th>Type of trader</th>
<th>How did you start poultry products marketing (%)</th>
<th>Origin of the money used to start poultry trade (%)</th>
<th>Capital at starting (FCFA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inheritance</td>
<td>Own initiative</td>
<td>Advice by friend/relatives</td>
</tr>
<tr>
<td>South</td>
<td>Assembler (n=23)</td>
<td>21.7</td>
<td>60.9</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>0.0</td>
<td>66.7</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=21)</td>
<td>95.2</td>
<td>0.0</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=20)</td>
<td>70.0</td>
<td>20.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>All (n=70)</td>
<td>55.7</td>
<td>31.4</td>
<td>12.9</td>
</tr>
<tr>
<td>North</td>
<td>Assembler (n=8)</td>
<td>25.0</td>
<td>75.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>33.3</td>
<td>50.0</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=14)</td>
<td>21.4</td>
<td>71.4</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=29)</td>
<td>53.6</td>
<td>39.3</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>All (n=57)</td>
<td>39.3</td>
<td>53.6</td>
<td>7.1</td>
</tr>
<tr>
<td>All regions</td>
<td>Assembler (n=31)</td>
<td>22.6</td>
<td>64.5</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>16.7</td>
<td>58.3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>65.7</td>
<td>28.6</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>60.4</td>
<td>31.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>48.4</td>
<td>41.3</td>
<td>10.3</td>
</tr>
</tbody>
</table>

Table 6.6. Distribution (%) of traders according to the quantity of poultry sold per month

<table>
<thead>
<tr>
<th>Type of bird</th>
<th>Type of trader</th>
<th>Number of birds/eggs per month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[0, 50]</td>
</tr>
<tr>
<td>Chicken</td>
<td>Assembler (n=31)</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>7.9</td>
</tr>
<tr>
<td>Chicken eggs</td>
<td>Assembler (n=31)</td>
<td>48.4</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>45.5</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>11.4</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>46.9</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>37.3</td>
</tr>
<tr>
<td>Duck</td>
<td>Assembler (n=31)</td>
<td>61.3</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>36.4</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>48.6</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>69.4</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>58.7</td>
</tr>
<tr>
<td>Guinea-fowl</td>
<td>Assembler (n=31)</td>
<td>45.2</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>27.3</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>31.4</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>57.1</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>44.4</td>
</tr>
<tr>
<td>Guinea-fowl eggs</td>
<td>Assembler (n=31)</td>
<td>48.4</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>63.3</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>42.1</td>
</tr>
</tbody>
</table>

Apart from these main middlemen, other types of actors involved in village poultry marketing are transporters, processors and individuals responsible for the market place. Processors (as used
in this chapter) are people whose job it is to help consumers (who buy live birds for consumption) to slaughter, de-feather and eviscerate birds according to the buyer’s wishes. This recent profession is essentially practiced by women. The amount taken for each processed bird varies between FCFA 100 to FCFA 200 for indigenous birds and FCFA 200 to FCFA 300 for exotic chickens.

_Individuals responsible of markets place_, named “sonon” (in local language _Fon_) focus on helping producers to sell their animals. For each animal sold, they take FCFA 25 to FCFA 50.

In sum, in the North, the percentage of women among village poultry traders increases when one moves from producers to consumers. In the South, male poultry traders mainly specialize in the trade of ducks and turkeys. Overall, the marketing activities are much more the domain of women in the South and men in the North. The educational level of the poultry traders varies greatly ranging from illiterate to secondary school.

6.3.3. Village poultry products distribution channels

The farmer brings her products to the primary market and sells them to assemblers, rural wholesalers or commissionaire agents who, in turn, resell the products to urban wholesalers who then move the products to the urban market and resell them to retailers or consumers.

There are various distribution channels (figure 6.2)\(^{38}\) for village poultry products and they can be categorized into three types: short, long and medium channels. The short channel goes directly from the producer to the consumer. Around 4% of village poultry products pass along this channel. The long channel is when poultry products move from the producer to the consumer via assemblers, rural wholesalers, urban wholesalers and retailers. Around 60% of poultry products pass along this channel. In this channel, an affinity between actors exists because they have traded together for a long time. The medium channel lies between these two types of channels.

According to the traders surveyed in the rural market of the North, poultry products purchased in their markets are mainly moved to Djougou, but also to Parakou, Cotonou, Natitingou (Northwest of Benin) and Togo Republic. From Djougou, roughly 90% of the poultry products are sent to the urban markets of Parakou (around 15%), Cotonou (60%), Porto-Novo (10%) and Natitingou (5%). For the traders surveyed in the rural markets of the southern region, poultry products purchased in their markets are transported to the urban markets of Cotonou and the surrounding areas (60%), Porto-Novo and surrounding areas (15%), and other urban and regional markets of the South (25%).

In general, and as shown in figure 6.2, village poultry marketing channels are complex and informal. The market channels show the involvement of many middlemen between the producer

\(^{38}\) Notice that all the percentage used in this section and on figure 6.2 are based mainly on the results of focus group discussion in research villages and markets.
and consumer. These characteristics are typical for most of the livestock marketing channels in West Africa, which is mainly due to the smallholder nature of livestock production in this region (Williams et al., 2006, p. 41). This has implications for increasing marketing costs because more intermediaries are involved between the smallholder producers (who are widely dispersed in space) and the consumers who are located several kilometers away (Williams et al., 2006, p. 41).

Figure 6.2. Village poultry marketing channels
The percentages in the figure are obtained through focus group discussions

6.3.4. Organization and entry barriers

About 34% of village poultry traders belong to a traders’ association/organization (table 6.7). The highest value is observed among urban wholesalers, with around 62% and 43% belonging to a traders’ organization in the South and the North, respectively. In the urban markets of Cotonou, these associations mainly concern the sale of poultry products, whilst in the other markets; associations are concerned with all agricultural products including poultry. In these urban markets, the aim of traders’ associations is to reduce or avoid the entry of new poultry product traders. This is why the majority of poultry traders in urban markets have inherited their activity (cf. table 6.5). In Dantokpa market (Cotonou), wholesalers clearly stated that only people whose parents (mother mainly) had been involved in the poultry trade or those who had served other
poultry traders for many years, are allowed to operate in their market as poultry traders. In the other studied markets, these associations are set up for social purposes: e.g. to assist members in case of difficulty.

Table 6.7. Proportion (%) of poultry traders that belong to a traders’ association

<table>
<thead>
<tr>
<th>Type of trader</th>
<th>South</th>
<th>North</th>
<th>All regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler (n=31)</td>
<td>13</td>
<td>0</td>
<td>9.7</td>
</tr>
<tr>
<td>Rural wholesaler (n=12)</td>
<td>33.3</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Urban wholesaler (n=35)</td>
<td>61.9</td>
<td>42.9</td>
<td>54.3</td>
</tr>
<tr>
<td>Retailer (n=49)</td>
<td>40</td>
<td>31</td>
<td>34.7</td>
</tr>
<tr>
<td>All (n=127)</td>
<td>37.1</td>
<td>29.8</td>
<td>33.9</td>
</tr>
</tbody>
</table>

6.4. Behavior of different marketing agents

6.4.1. Sale price setting

In general, agreement on the price of products is reached through haggling, i.e. discussion between the buyer and seller. In the surveyed markets, factors that can affect the price of poultry products are: the bargaining power of the seller/buyer, the breed (indigenous animal is more expensive than crossbred), the size and weight of the animal, its health status (a healthy animal is more expensive than a weak animal), the color of its plumage and other subjective factors related to the buyer such as the language spoken (at the consumer level, when the buyer and seller speak the same language the final price is often lower than if they speak a different language), clothing (well dressed people pay a higher price) and the sex of the consumer (price paid by men is often higher than the that paid by women).

In the surveyed market, the risk of middlemen purchasing sick birds, which are more prone to dying before being sold is high. To avoid buying weak or sick birds, traders shake and hit the back of the bird. These strategies are also used in other countries such as Myanmar where Henning et al. (2006) state that middlemen have different methods to verify the health of birds: squeezing the wings; hitting the back of a bird – healthy birds should not make a noise.

6.4.2. Information

Village poultry traders were asked to state whether they search for information on the market situation and prices before going to buy or sell poultry products. Roughly 75% of them responded negatively. In other words, only 25% of the traders searched for information regarding the market situation of poultry products. This information is gathered from friends or from other poultry traders and mainly concerns the state of demand and supply regarding poultry products. In general, the circulation of information is done by word of mouth.
One of the main reasons why traders do not search for information is that the markets are often far-away and the access is not good. Another reason is that the source of information is often unavailable since there is no formal information system on poultry prices.

At the official level (as noted in section 6.2.3), information on the price of poultry products is only available at the consumer level at the urban market of Cotonou. In other urban areas, no information is available on poultry products in general.

In this situation, the monopoly of information on prices is held by urban wholesalers who are therefore the main price makers. Indeed, only these actors know the real situation at the urban/consumption markets and the rural markets. There is then a lack of transparency on the poultry market, which adds to the difficulty of accessing rural markets, indicating that the free circulation of information is not assured. Accordingly, the producers are the ones who lose the most as they are price takers. They are losers because traders can easily impose the sale price on them. In the same way, the producers are weakened since they often take their products to market when they have various problems: when cash is needed, when disease has occurred in the flock/village and so on. In the same way, following Islam (2003), producers receive a low price for their products because they are too far from the consumers, unable to find out what the consumer wants and are too small as regards output.

As stated by Omiti et al. (2009), these findings demonstrate the urgent need to strengthen market information delivery systems, upgrade roads in rural areas, encourage market integration initiatives, and establish more retail outlets with improved market facilities in the remote rural villages in order to promote production and trade in high value commodities by rural farmers. Better output prices and market information are key incentives for increased sales (Omiti et al., 2009).

6.4.3. Traders’ marketing strategies

The strategies used by the middlemen to gain profit from their activities depend upon the trader. The first strategy usually used by assemblers and wholesalers is to give credit to producers during periods of hardship, when their food stores are empty, in order to guarantee the delivery of the next poultry products. In this way, the trader who gave the producer the loan ensures that the producer cannot sell his products to other traders. In this case, and as stated in section 6.3.1, the trader is obliged to go to the producer’s home.

The second strategy consists of making friends with the producer by giving him gifts or assistance during difficult periods. This strategy does not guarantee the delivery of the next poultry products, but it can help the trader to find out the day or period during which the producer wishes to sell his products.
The third strategy used by the assemblers is to reduce transportation costs by transporting their products on their heads and walking from village to village. Gondwe et al. (2005) report the same result in Malawi where middlemen at the rural markets minimized poultry transaction costs by using low (or no) cost forms of transportation such as cycling or walking.

To reduce the transaction costs, traders also used to buy goods other than poultry products (fourth strategy). This strategy allows them not only to reduce poultry transaction costs, but also to compensate for the eventual losses on one product with profits earned on another. Other types of products sold by 23% of assemblers (table 6.8) are banana, snails, corn, small ruminants and fish. Rural wholesalers (17%) also sell small ruminants and dogs. Among urban wholesalers, 13% of them sell condiments and fruit. Among the retailers of the South, 30% diversify products sold such as vegetables, small ruminants, staple products (corn, bean, yam, rice, etc.) and medicines.

Table 6.8. Poultry product traders who are engaged in the poultry trade as main activity (%)

<table>
<thead>
<tr>
<th>Agents</th>
<th>South</th>
<th>North</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler (n=31)</td>
<td>87.0</td>
<td>50.0</td>
<td>77.4</td>
</tr>
<tr>
<td>Rural wholesaler (n=12)</td>
<td>83.3</td>
<td>83.3</td>
<td>83.3</td>
</tr>
<tr>
<td>Urban wholesaler (n=35)</td>
<td>85.7</td>
<td>92.9</td>
<td>88.6</td>
</tr>
<tr>
<td>Retailer (n=49)</td>
<td>70.0</td>
<td>96.6</td>
<td>85.7</td>
</tr>
<tr>
<td>All (n=127)</td>
<td>81.4</td>
<td>87.7</td>
<td>84.3</td>
</tr>
</tbody>
</table>

The haggling, which is the main strategy used in village poultry transaction, has a negative effect on the producer. In periods of abundance, the final transaction price often goes against the producer as they lack information and are not skilled in discussing prices. Also, in this period, they are in need of money to solve various problems. In periods of scarcity, the final transaction price is against the producer and the consumer. At this time, urban wholesalers exploit the consumers’ and rural wholesalers’ low access to information by imposing the selling price on them. Rural wholesalers pass the selling price on to assemblers, who in turn pass it on to the producer. Eventually, in periods of abundance or scarcity, the producer is the main loser in this strategy of price settlement.

Finally, roughly 14% of traders (mainly assemblers and rural wholesalers) buy birds of the same species in groups of two or three live animals. This strategy, according to some traders, allows them to reduce the unit price of purchase by 2% to 5% depending on their haggling ability. In all cases, at the consumer level, birds are sold per unit.
6.5. **Performance of village poultry markets**

6.5.1. **Price movement over time and space**

Figures 6.3 to 6.5 indicate that the price of chickens, ducks and guinea-fowl vary according to season and space\(^{39}\). In general, product prices in urban markets are higher than those observed in rural markets. These prices vary almost in the same direction: prices decrease and increase in the same period of the year. This result means that there is probably a close relationship between the price paid to the producers in rural markets and the selling price in the urban markets. Put differently, there would be integration between these markets.

- **Chicken**

For chickens, figure 6.3 shows that the selling price is low in May-June. This can be explained by the fact that May-June is a period of hardship, when the food stores are empty. The majority of farmers take the majority of their poultry products to market during this period, which results in a decrease in the price of chicken due to an increase in supply. Sodjinou and Koudande (2008) also found the same results in the Central and the Southern part of Benin where they showed that in this period, the producer takes chicken to the market in order to be able to buy cereal for the family. It is mainly during this period that producers ask for credit from traders.

During the harvesting period from July-August when the food stores are filled of cereals, producers reduce their supply causing an increase in the chicken price. During September-October, the chicken price decreases again. In fact, this period is characterized by the emergence of various diseases, especially Newcastle disease. To avoid losing the entire chicken flock, producers, in particular those who do not vaccinate their poultry and do not provide shelter, take their products to market. September-October is also the time when children return to school. According to Sodjinou and Koudandé (2008), during this period, the breeders need money to purchase school supplies for children and to pay school fees and various subscriptions. Many village breeders thus take their products to the market, which causes a slight decrease in the price of chicken. In other words, the supply is relatively abundant in this period, but the demand is low. Producers also usually ask for a loan from traders during September to October to finance children’s schooling.

During November-December, the price of chicken increases again. These months are when the main festivals are held, in particular Christmas, New Year and other religious holidays. The demand for poultry products in general is thus high, with a relatively weak supply. This price level for poultry is maintained until January, the month which is dedicated to voodoo (indigenous religion) in Benin. In February, the chicken price often decreases. In fact, during this period, farmers usually take their chicken to market in order to avoid losing all their chickens to disease.

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\(^{39}\) Figure 6.3 to 6.5 are based on data collected between May 2008 and April 2009.
In contrast to chicken, the price variation of which mainly depends on the financial need of the breeder and diseases, the price of guinea-fowl often follows a reproduction cycle. The price of guinea-fowl is high in May-June due to a decrease in its supply (figure 6.4). Indeed, the guinea fowl lay eggs from April to June, which means that adult guinea-fowl are available in August. As a consequence, the supply of guinea-fowl is high during August-September and so the price decreases during this period. In November-December, the price increases due to increasing demand because of various festivals.

Duck

In all markets (figure 6.5), the price of duck is low in March-April in the two regions, and also in September-October in the North. The highest prices occurred during November-December, the festival period during which the demand for poultry products is very high. In general, the supply of duck is mainly affected by the high level of duckling mortality.

Most of these results, especially the seasonal price variation, match those obtained by various authors in other countries. For example, in Myanmar, chicken are generally sold when money is needed, in particular during religious festivals (Henning et al., 2006). Henning et al. also stated that low chicken prices are paid during June/July when there is less demand for chickens as there is more fish available for consumption. Low demand also occurs in June as school fees have to be paid in that month (Henning et al., 2006).

Figure 6.3. Chicken price (FCFA/kg of live weight) variation through seasons in the South (on the left) and the North (on the right)
6.5.2. Market integration analysis

For chickens, table 6.9 shows that the correlation coefficient is high between the rural markets of the South (Doutou, Lobogo and Avakpa) and the urban markets of the same region (Ouando and Dantokpa). Therefore, there is integration between these two categories of markets. The same situation is observed between the rural and urban markets of the North; indicating integration between them.

For ducks, there is integration between the rural and urban markets of the South. In the North, Djougou (urban market) seems to be less integrated in the duck market, since the correlation is low and insignificant between this market and other markets such as Parakou and Kolokondé. Djougou also seems to be less integrated with the urban markets of the South (Dantokpa and Ouando). Besides, there is integration between other rural markets of the North and urban markets of the same region.
For guinea-fowl one can say that the rural and urban markets of the South are integrated, since the correlation coefficients between the prices on these markets are superior to 0.8 and significant at 5 % level. In the North, it seems that there is no integration between the Kolokonde market and Djougou and between Kassua and Parakou.

In short, there is high integration between various rural and urban markets of the same region, based on chicken price. In the North, Djougou seems to be less integrated into the duck market, and Kassua seems to be less integrated into the guinea fowl market.

Table 6.9. Poultry prices: bivariate correlation between surveyed markets (May 2008 – April 2009)

(a) chicken

<table>
<thead>
<tr>
<th></th>
<th>Avakpa$^{(1)}$</th>
<th>Lobogo$^{(1)}$</th>
<th>Dantokpa$^{(2)}$</th>
<th>Doutou$^{(1)}$</th>
<th>Ouando$^{(2)}$</th>
<th>Kolokonde$^{(3)}$</th>
<th>Djougou$^{(4)}$</th>
<th>Kassua$^{(5)}$</th>
<th>Parakou$^{(4)}$</th>
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</thead>
<tbody>
<tr>
<td>Lobogo$^{(1)}$</td>
<td>0.97***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dantokpa$^{(2)}$</td>
<td>0.91** 0.92***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doutou$^{(1)}$</td>
<td>0.92*** 0.94*** 0.93***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ouando$^{(2)}$</td>
<td>0.94*** 0.92*** 0.98*** 0.95***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kolokonde$^{(3)}$</td>
<td>0.96*** 0.97*** 0.95*** 0.88*** 0.94***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djougou$^{(4)}$</td>
<td>0.93*** 0.94*** 0.81** 0.77* 0.80*</td>
<td>0.95***</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Kassua$^{(5)}$</td>
<td>0.91*** 0.94*** 0.93*** 0.84** 0.91***</td>
<td>0.98*** 0.92***</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Parakou$^{(4)}$</td>
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<td>0.98*** 0.88** 0.98***</td>
<td></td>
<td></td>
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</table>

(b) duck

<table>
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<th>Dantokpa</th>
<th>Doutou</th>
<th>Ouando</th>
<th>Kolokonde</th>
<th>Djougou</th>
<th>Kassua</th>
<th>Parakou</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>0.90**</td>
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<td></td>
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<td></td>
</tr>
<tr>
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<td>0.90**</td>
<td>0.98***</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ouando</td>
<td>0.88**</td>
<td>0.89**</td>
<td>0.97***</td>
<td>0.92</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Kolokonde</td>
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<td>0.61</td>
<td>0.81**</td>
<td>0.76*</td>
<td>0.66</td>
<td></td>
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<td>Djougou</td>
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<td>0.38</td>
<td>0.66</td>
<td></td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kassua</td>
<td>0.88**</td>
<td>0.81*</td>
<td>0.93***</td>
<td>0.84**</td>
<td>0.93***</td>
<td>0.79*</td>
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</tr>
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<td>Parakou</td>
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<td>0.98***</td>
<td>0.73*</td>
<td>0.56</td>
<td>0.94***</td>
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</table>

(c) Guinea fowl

<table>
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<th>Dantokpa</th>
<th>Doutou</th>
<th>Ouando</th>
<th>Kolokonde</th>
<th>Djougou</th>
<th>Kassua</th>
<th>Parakou</th>
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<tr>
<td>Lobogo</td>
<td>0.83**</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Dantokpa</td>
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<td>0.97***</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Doutou</td>
<td>0.90**</td>
<td>0.94***</td>
<td>0.91**</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ouando</td>
<td>0.84**</td>
<td>0.98***</td>
<td>0.98***</td>
<td>0.90***</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Kolokonde</td>
<td>0.88**</td>
<td>0.82**</td>
<td>0.78*</td>
<td>0.81**</td>
<td>0.78*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djougou</td>
<td>0.65</td>
<td>0.94***</td>
<td>0.84**</td>
<td>0.87**</td>
<td>0.88**</td>
<td>0.76*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kassua</td>
<td>0.50</td>
<td>0.80*</td>
<td>0.63</td>
<td>0.80*</td>
<td>0.71</td>
<td>0.60</td>
<td>0.91**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parakou</td>
<td>0.92***</td>
<td>0.95***</td>
<td>0.98***</td>
<td>0.96***</td>
<td>0.96***</td>
<td>0.78*</td>
<td>0.81**</td>
<td>0.66</td>
<td></td>
</tr>
</tbody>
</table>

N = 6, *** Significant at 1%, ** significant at 5%, significant at 10%

(1) Rural market of the South, (2) Urban market of the South, (3) Rural market of the North, (4) Urban market of the North
6.5.3. Village poultry transaction costs

- Equipment and taxes
The main equipment used by poultry traders are (table 6.10) small birdcages for transport (68% of them), large birdcages for transport (72%), baskets made with the rib of palm (78%), and other (bicycles, motorcyles, baskets made of plastic, etc.). In the South, assemblers transport their products on their heads and only 4% have a bicycle, whilst none use a motorcycle. This practice allows them to reduce transport costs. On the other hand, in the North, traders use motorcycles and bicycles, particularly assemblers (roughly 88% of them own a bicycle), rural wholesalers (100% have a bicycle) and urban wholesalers (79% own a motorcycle). This situation can be explained by the fact that in the northern region, villages are distant from each other.

As stated in section 6.3.1, tax payment depends on the region and the type of agents considered. Thus, in the South, producers do not pay taxes on their goods. However, in the North, all producers pay FCFA 50 on each bird sold. In the South as well as the North, all traders pay municipal taxes. In urban markets, traders pay tax on their stalls and on each bird sold. In rural markets, traders only pay tax on the goods sold.

Table 6.10. Village poultry traders’ equipment

<table>
<thead>
<tr>
<th>Region</th>
<th>Type of trader</th>
<th>Small birdcage</th>
<th>Big birdcage</th>
<th>Basket</th>
<th>Bicycle</th>
<th>Motorcycle</th>
<th>Plastic bucket</th>
<th>Other</th>
</tr>
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<tbody>
<tr>
<td>South</td>
<td>Assembler</td>
<td>65.2</td>
<td>30.4</td>
<td>91.3</td>
<td>4.3</td>
<td>0.0</td>
<td>13.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler</td>
<td>100.0</td>
<td>33.3</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler</td>
<td>81.0</td>
<td>100.0</td>
<td>81.0</td>
<td>0.0</td>
<td>4.8</td>
<td>4.8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Retailer</td>
<td>75.0</td>
<td>95.0</td>
<td>70.0</td>
<td>5.0</td>
<td>10.0</td>
<td>5.0</td>
<td>0.0</td>
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<tr>
<td></td>
<td>All</td>
<td>75.7</td>
<td>70.0</td>
<td>82.9</td>
<td>2.9</td>
<td>4.3</td>
<td>7.1</td>
<td>0.0</td>
</tr>
<tr>
<td>North</td>
<td>Assembler</td>
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<td>62.5</td>
<td>75.0</td>
<td>87.5</td>
<td>37.5</td>
<td>0.0</td>
<td>0.0</td>
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<td>50.0</td>
<td>83.3</td>
<td>100.0</td>
<td>33.3</td>
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<td>0.0</td>
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<tr>
<td></td>
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<td>57.1</td>
<td>100.0</td>
<td>92.9</td>
<td>28.6</td>
<td>78.6</td>
<td>7.1</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>Retailer</td>
<td>58.6</td>
<td>69.0</td>
<td>58.6</td>
<td>41.4</td>
<td>27.6</td>
<td>6.9</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>57.9</td>
<td>73.7</td>
<td>71.9</td>
<td>50.9</td>
<td>42.1</td>
<td>5.3</td>
<td>1.8</td>
</tr>
<tr>
<td>All regions</td>
<td>Assembler</td>
<td>64.5</td>
<td>38.7</td>
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<td>9.7</td>
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<td>Rural wholesaler</td>
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<td>91.7</td>
<td>50.0</td>
<td>16.7</td>
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<td>100.0</td>
<td>85.7</td>
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<td>34.3</td>
<td>5.7</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Retailer</td>
<td>65.3</td>
<td>79.6</td>
<td>63.3</td>
<td>26.5</td>
<td>20.4</td>
<td>6.1</td>
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<td>71.7</td>
<td>78.0</td>
<td>24.4</td>
<td>21.3</td>
<td>6.3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

- Transaction costs
The highest transaction cost is noted at the retailer level (roughly FCFA 168 per kg of chicken in the South and FCFA 297 per kg in the North), whereas the lowest cost is observed at the level of rural wholesalers in the South (FCFA 72 per kg) and the level of urban wholesalers (FCFA 57
The distribution of the traders according to the level of the transaction costs (figure 6.6) indicates that roughly 76% of retailers, 14% of urban wholesalers, 18% of rural wholesalers and 42% of assemblers have transaction costs which are higher than FCFA 100 per kg. Most of the urban wholesalers (49%) have transaction costs, which are less than FCFA 50 per kg. About 55% of the rural wholesalers have transaction costs between FCFA 50 and FCFA 100 per kg. The difference observed between traders can be mainly explained by the quantity of poultry products sold by each trader.

Figure 6.6. Distribution of poultry traders according to the level of transaction costs (in FCFA/kg of chicken)

- **Transaction costs structure**

The analysis of the transaction costs structure (table 6.11) indicates that transport is the main transaction cost for village poultry for all traders apart from assemblers in the North. Indeed, transport comprises 35% to 47% of the total transaction costs in the South and 25% to 33% in the North. Therefore, a reduction in village poultry transaction costs can be achieved through a reduction in transport costs. In other words, improved transport conditions (quality of the road, transport means, etc.) are necessary to reduce village poultry transaction costs. Indeed, following Fafchamps and Gabre-Madhin (2006), there is ample scope for lowering marketing costs by reducing transport costs and various policies could be used. Direct measures, such as reducing gasoline taxes, would undoubtedly have an effect, but at the expense of much needed government revenue. Measures to improve the maintenance of rural feeder roads are urgently needed. Devolving maintenance to local administration is an option worth examining, as is the creation of toll roads to finance maintenance costs (Fafchamps and Gabre-Madhin, 2006).

The second largest factor in village poultry transaction costs is depreciation followed, in most of the cases, by taxes and storage costs. Thus, the second most important aspect requiring intervention is the improvement of poultry selling equipment.
Table 6.11. Village poultry products transaction cost structure (% of total transaction cost)

<table>
<thead>
<tr>
<th>Region</th>
<th>Agents</th>
<th>Depreciation</th>
<th>Transport</th>
<th>Handling</th>
<th>Tax</th>
<th>Storage</th>
<th>Other costs</th>
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<td>12.6</td>
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<td>Rural wholesaler (n=6)</td>
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<td>36.9</td>
<td>6.7</td>
<td>5.5</td>
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<td>Urban wholesaler (n=21)</td>
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<td>9.0</td>
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<td>11.8</td>
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<td>10.5</td>
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<td>9.5</td>
<td>10.7</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>23.0</td>
<td>35.7</td>
<td>10.4</td>
<td>8.2</td>
<td>16.9</td>
<td>5.8</td>
</tr>
</tbody>
</table>

6.5.4. Traders’ margin analysis

- Absolute marketing margin

In the South, the highest absolute marketing margin on a kilogram of chicken sold is obtained by the urban wholesaler, with 95% of them having more than FCFA 300 per kg (figure 6.7). In contrast, rural wholesalers benefit mainly from ducks (figure 6.8), whereas retailers obtain their highest profits on guinea-fowl (figure 6.9). In the North, the highest absolute marketing margin on chicken belongs to retailers, with roughly 66% of them obtaining more than FCFA 200 per kg. Regarding ducks in the North, the highest absolute marketing margins are achieved by rural wholesalers (60% of them get more than FCFA 200 as an absolute marketing margin per kg) and assemblers (67% of them get more than FCFA 200 per kg). Regarding guinea-fowl, 67% of the assemblers in the North have more than FCFA 200 as an absolute marketing margin.

A = Assembler, RW = Rural wholesalers, UW = Urban wholesalers, R = Retailers

Figure 6.7. Distribution of traders according to the level of absolute marketing margin on chickens (FCFA)
**Relative marketing margin**

Figures 6.10 to 6.12 show that, for chicken and guinea-fowl, traders of the south gain more than those of the North. Concerning duck, traders of the North have more profit than those of the South. Indeed, in the North, 57% of assemblers have a relative marketing margin superior to 50 on guinea-fowl (Figure 6.12). On the other hand, 67% of rural wholesalers and 61% of retailers have a relative marketing margin inferior to 25%. 62% of urban wholesalers have a relative marketing margin between 25% and 50%, in the North. On duck, the highest relative marketing margin is obtained by assembler and rural wholesalers (Figure 6.11). On chicken, 55% of the retailers have less than 25% as relative marketing margin (Figure 6.10). Most of the urban wholesalers have a relative marketing margin that ranges from 25% to 50%.

In the South, 67% of the urban wholesalers have more than 50% as relative marketing margin compared with 70% of the assemblers who 25% to 50% as relative marketing margin on chicken.
A = Assembler, RW = Rural wholesalers, UW = Urban wholesalers, R = Retailers

**Figure 6.10. Distribution of traders according to the level of relative marketing margins on chicken (FCFA)**

**Figure 6.11. Distribution of traders according to the level of relative marketing margins on duck (FCFA)**

**Figure 6.12. Distribution of traders according to the level of relative marketing margins on guinea fowl (FCFA)**
- **Gross and net marketing margins**

Concerning the total gross marketing margin, figure 6.13 shows that urban wholesalers have the highest benefits in the South (roughly 95% of them receive more than FCFA 200,000 per month) as well as the North (with 64% receiving more than FCFA 200,000 per month). Retailer and rural wholesalers come in second position in the South and the North respectively. The net marketing margin indicates that urban wholesalers obtain the highest profit per month in the two regions. The assembler records the lowest gross and net marketing margins, about 96% in the South and 88% in the North receive less than FCFA 100,000 per month.

The gross and net marketing margins per kilogram of chicken sold (figure 6.14) also show that urban wholesalers obtain the highest profit from village poultry marketing. These results clearly show that village poultry marketing is profitable.

![Figure 6.13. Distribution of traders according to the level of the gross (on the left) and net marketing margins (on the right) (in 1,000 FCFA/month)](image)

A = Assembler, RW = Rural wholesalers, UW = Urban wholesalers, R = Retailers

![Figure 6.14. Distribution of traders according to the level of the gross (on the left) and net marketing margins (on the right) (in 1,000 FCFA/kg)](image)

A = Assembler, RW = Rural wholesalers, UW = Urban wholesalers, R = Retailers
• Traders’ perceptions of the profitability of village poultry marketing

To assess traders’ perceptions of this profitability, they were asked if they wanted to abandon the poultry trade. The objective was to appreciate their attitude vis-à-vis the actual situation of the village poultry sector. In principle, if the sector is not good, most traders will want to abandon. The results obtained and presented in table 6.12 indicate that the majority of traders do not want to leave the village poultry trade. Indeed, only 7% to 8% of the traders expressed a desire to abandon the activity. The analysis by type of agent shows that no rural and urban wholesalers want to abandon the village poultry trade. It is mainly among the assemblers in the North that the rate of abandonment is high, between 22% and 29%. Those who want to quit think that the poultry trade constitutes for them a transient activity that they will abandon sooner or later for something else. Therefore, the problem is not the profitability of the activity, but rather a desire that poultry trade should not be the main income generating activity. In short, traders’ perception indicates that village poultry trade is profitable.

Village poultry traders gain large marketing margins. This can be due to poor transport and communication infrastructure that give rise to large marketing margins because of the high costs of delivering products to destinations (Babiker and Abdalla, 2009). Babiker and Abdalla (2009) also argued that this may also hinder the transmission of price signals because of non-competitive behavior among traders. Thus, infrastructural development can play an important role in supporting the integration of poultry markets, facilitating competition, encouraging investment, and allowing a more efficient allocation of resources and enhancing market-oriented production (Babiker and Abdalla, 2009).

Table 6.12. Poultry traders who are willing to abandon village poultry trade (% of yes)

<table>
<thead>
<tr>
<th>Region</th>
<th>Type of trader</th>
<th>Chicken</th>
<th>Duck</th>
<th>Guinea-fowl</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Assembler (n=23)</td>
<td>21.7</td>
<td>28.6</td>
<td>27.8</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=21)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=20)</td>
<td>5.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>All (n=70)</td>
<td>8.6</td>
<td>11.1</td>
<td>8.6</td>
</tr>
<tr>
<td>North</td>
<td>Assembler (n=8)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=6)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=14)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=29)</td>
<td>10.3</td>
<td>8.7</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td>All (n=57)</td>
<td>5.3</td>
<td>4.1</td>
<td>5.7</td>
</tr>
<tr>
<td>All regions</td>
<td>Assembler (n=31)</td>
<td>16.1</td>
<td>20.7</td>
<td>19.2</td>
</tr>
<tr>
<td></td>
<td>Rural wholesaler (n=12)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Urban wholesaler (n=35)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Retailer (n=49)</td>
<td>8.2</td>
<td>5.4</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>All (n=127)</td>
<td>7.1</td>
<td>7.8</td>
<td>7.2</td>
</tr>
</tbody>
</table>
6.6. Traders’ preference for poultry characteristics

- Traders’ ranking of poultry attributes

Traders’ preferred poultry characteristics have been analyzed through their perception and through the use of hedonic regression. Concerning traders’ perceptions, traders were asked to rank their preferred poultry characteristics when purchasing chickens, ducks or guinea fowl. Table 6.13 shows that the weight/meatiness constitutes the first factor affecting the village poultry price. For chicken, the second characteristic is the color of the plumage, and the sex of the bird comes in third position followed by the breed and animal size. For guinea-fowl, the size is the second most important factor, followed by the sex and the breed. As for ducks, the sex of the animal is the second most important factor followed by the size of the animal. The plumage color and the breed come in fourth and fifth positions respectively.

Table 6.13. Traders’ preferred village poultry characteristics: results of Kendal concordance test

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Chicken</th>
<th>Guinea-fowl</th>
<th>Duck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td>4 (4.09)</td>
<td>4 (4.42)</td>
<td>5 (4.66)</td>
</tr>
<tr>
<td>Color of the plumage</td>
<td>2 (3.86)</td>
<td>5 (4.71)</td>
<td>4 (4.26)</td>
</tr>
<tr>
<td>Height on leg</td>
<td>5 (4.36)</td>
<td>2 (3.98)</td>
<td>3 (4.16)</td>
</tr>
<tr>
<td>Weight/Meatiness</td>
<td>1 (2.04)</td>
<td>1 (1.67)</td>
<td>1 (2.07)</td>
</tr>
<tr>
<td>Origin</td>
<td>7 (6.11)</td>
<td>7 (6.36)</td>
<td>7 (6.47)</td>
</tr>
<tr>
<td>Other criteria</td>
<td>6 (5.75)</td>
<td>6 (5.18)</td>
<td>6 (5.54)</td>
</tr>
<tr>
<td>Sex</td>
<td>3 (3.97)</td>
<td>3 (4.37)</td>
<td>2 (3.37)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Chicken</th>
<th>Guinea-fowl</th>
<th>Duck</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>128</td>
<td>112</td>
<td>90</td>
</tr>
<tr>
<td>Kendall's W</td>
<td>0.319</td>
<td>0.355</td>
<td>0.362</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>286.06***</td>
<td>277.96***</td>
<td>228.34***</td>
</tr>
</tbody>
</table>

( ): Numbers in parentheses are mean ranks; *** Significant at 1% with df = 6

- Results of hedonic price regression

Traders’ perceptions are consistent with the results of the hedonic regression (table 6.14). Indeed, the color of the plumage has a significant and positive influence (at 1% level) on the chicken price. Price tends to increase by 0.11% for white chickens, which indicates that buyers are willing to pay about FCFA 166 for a white chicken (table 6.15). The significant and positive effect of the white color on the chicken price is related to the religious use of the birds. Indeed, chickens are sacrificed during various traditional ceremonies. Chickens that have white plumage are offered in sacrifice to the voodoo god named Doudoua, whereas those with red plumage are destined for the god “Hebiosso” (god of the thunder). For chickens termed Kpinkoun (white speckled with black plumage), these are sacrificed to the voodoo gods “Dan” and “Sakpata.” To ward off bad fate and to ask for good luck, chickens with black, white or red plumage are used. Sacrifices performed to invoke the spirit of death require chickens with black plumage. However, a black color does not have a significant effect on the chicken price, since this color is
widely available. It is also relevant to note that chicks which are a maximum of one month of age are frequently sacrificed to the voodoo god “Tron.”

Guinea-fowl with white plumage speckled with black are especially used in sacrifices to the voodoo god “Doukounou” (owner of wealth) in order to ask for good wealth. Guinea-fowl with black plumage are used for ceremonies / sacrifices to death’s forebears (kouvito). According to those who perform this practice, it allows them to improve their luck and success in life. Ducks with white plumage or ash are preferred for the dowry of women.

Table 6.14. Estimation of hedonic price model for poultry

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Chicken</th>
<th>Duck</th>
<th>Guinea fowl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficients</td>
<td>Coefficients</td>
<td>Coefficients</td>
</tr>
<tr>
<td></td>
<td>t</td>
<td>t</td>
<td>t</td>
</tr>
<tr>
<td>Breed (1=indigenous, 0=otherwise)</td>
<td>0.399**</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td></td>
<td>(0.165)</td>
<td>(0.116)</td>
<td>(0.136)</td>
</tr>
<tr>
<td>Height (1=long, 0=otherwise)</td>
<td>0.142**</td>
<td>0.222*</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td>(0.118)</td>
<td>(0.136)</td>
</tr>
<tr>
<td>Sex (1=male, 0=female)</td>
<td>0.200</td>
<td>0.699**</td>
<td>-0.084</td>
</tr>
<tr>
<td></td>
<td>(0.123)</td>
<td>(0.289)</td>
<td>(0.185)</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White (yes=1)</td>
<td>0.108**</td>
<td>-0.129</td>
<td>-0.100</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.111)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>Black (yes=1)</td>
<td>-0.056</td>
<td>-0.214**</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.103)</td>
<td>(0.094)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>0.441***</td>
<td>0.114</td>
<td>0.257**</td>
</tr>
<tr>
<td></td>
<td>(0.082)</td>
<td>(0.076)</td>
<td>(0.099)</td>
</tr>
<tr>
<td>Meatiness (1=highly meaty, 0=otherwise)</td>
<td>0.296***</td>
<td>-0.192</td>
<td>-0.084</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
<td>(0.126)</td>
<td>(0.097)</td>
</tr>
<tr>
<td>Age of the bird</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥6 – 12] months</td>
<td>0.131*</td>
<td>0.005</td>
<td>0.134</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
<td>(0.102)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>≤6 months</td>
<td>-0.055</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td></td>
<td>(0.080)</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Breed * Weight</td>
<td>-0.119</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Sex * Weight</td>
<td>-0.152**</td>
<td>-0.156</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>(0.075)</td>
<td>(0.094)</td>
<td>(0.116)</td>
</tr>
<tr>
<td>(Constant)</td>
<td>6.677***</td>
<td>7.945***</td>
<td>7.445</td>
</tr>
<tr>
<td></td>
<td>(0.130)</td>
<td>(0.160)</td>
<td>(0.236)</td>
</tr>
<tr>
<td>F</td>
<td>23.884***</td>
<td>3.121**</td>
<td>8.579**</td>
</tr>
<tr>
<td>R</td>
<td>0.853</td>
<td>0.687</td>
<td>0.861</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.728</td>
<td>0.471</td>
<td>0.741</td>
</tr>
<tr>
<td>Adjusted R Squared</td>
<td>0.698</td>
<td>0.320</td>
<td>0.655</td>
</tr>
<tr>
<td>N</td>
<td>110</td>
<td>37</td>
<td>33</td>
</tr>
</tbody>
</table>

( ) Standard errors in parentheses; NN: Not Need; Nd: Not determined

*** Significant at 1%, ** Significant at 5%, Significant at 10%*

The breed of the bird has a positive and significant (at 1% level) effect on the price of chicken. The chicken price tends to be, ceteris paribus, 22% higher for indigenous chicken, which
indicates that traders are willing to pay, *ceteris paribus*, roughly FCFA 342 more for indigenous chickens than for crossbreeds. This result can be explained by the consumers’ perception of indigenous chicken, which is often named "bicycle chicken." Indeed, during the focus group discussion carried out in the research villages and markets, people stated that consumers from urban areas prefer indigenous breeds not only for their organoleptic qualities (tastier and with a nicer smell), but also for their dietetic qualities. In the latter case, the consumers think that the local chicken contains less fat than improved chicken, and thus its consumption is suitable for diabetics. This result also supports those of Djondo (2001) who found that 90% of interviewees preferred local chickens. Similarly, Sonaiya and Swan (2004) argue that local consumers generally prefer the eggs and meat from indigenous stocks rather than commercial hybrid birds (derived from imported stock). Thus, consumers offer a higher price premium for indigenous birds’ meat because: (i) the meat is considered to be tastier than commercial broiler meat, (ii) the meat (muscle tissue) is tougher, and retains its texture when prepared in dishes requiring longer cooking; and (iii) the birds are not fed with compounded feed, which may contain antibiotics, anti-mould compounds, enzymes and other medicines or synthetic chemicals (Sonaiya and Swan, 2004). In the same way, following Djondo (2001), people think that the local chickens are natural, nourishing and tasty containing no chemical products.

These results are in accordance with Bessadok et al. (2003) and show that, despite the genetic erosion over the centuries, local chicken populations still have significant variability, which results in excellent quality meet and the preservation of a unique genetic reserve of various characteristics (i.e. color, form, rusticity, etc.).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Chicken Relative change (1)</th>
<th>Chicken Absolute change (2)</th>
<th>Duck Relative change (4)</th>
<th>Duck Absolute change (5)</th>
<th>Guinea fowl Relative change (6)</th>
<th>Guinea fowl Absolute change (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>0.108</td>
<td>165.6</td>
<td>-0.129</td>
<td>-475.5</td>
<td>-0.100</td>
<td>-279.3</td>
</tr>
<tr>
<td>Black</td>
<td>-0.056</td>
<td>-86.7</td>
<td>-0.214</td>
<td>-786.7</td>
<td>0.042</td>
<td>115.9</td>
</tr>
<tr>
<td>Breed</td>
<td>0.222</td>
<td>341.6</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.026</td>
<td>-39.7</td>
<td>0.285</td>
<td>1045.0</td>
<td>0.010</td>
<td>27.6</td>
</tr>
<tr>
<td>Weight</td>
<td>0.323</td>
<td>496.1</td>
<td>0.055</td>
<td>200.8</td>
<td>0.292</td>
<td>811.3</td>
</tr>
<tr>
<td>Age1 (3-6 months)</td>
<td>-0.055</td>
<td>-84.8</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Age2 (6-12 months)</td>
<td>0.131</td>
<td>202.2</td>
<td>0.005</td>
<td>17.2</td>
<td>0.134</td>
<td>373.4</td>
</tr>
<tr>
<td>Meatiness</td>
<td>0.296</td>
<td>455.8</td>
<td>-0.192</td>
<td>-704.2</td>
<td>-0.084</td>
<td>-233.6</td>
</tr>
<tr>
<td>Height</td>
<td>0.142</td>
<td>219.1</td>
<td>0.222</td>
<td>815.1</td>
<td>0.003</td>
<td>8.7</td>
</tr>
</tbody>
</table>

(1) Relative change (partial derivative) of price if x is increased by 1 unit  
(2) Absolute change (hedonic price in FCFA) of price if x is increased by 1 unit  
Nd: Not determined

The weight of the bird has a positive and significant effect on the price of chicken (at 1% level) and guinea fowl (at 5% level) with the price of chicken increasing by 32% for every additional kg in weight. Table 6.15 shows that traders have a high willingness to pay for this characteristic,
roughly FCFA 4.96 for an additional kg. In the same way, the price of guinea fowl increases by 29% for every 1 kg change in weight, which indicates that traders are willing to pay roughly FCFA 811 for an additional kg. Besides, the interaction between the weight of chicken and the sex is significant at 5% level. This result implies that the trader’s willingness for an additional kg is 15 percentage points higher for female chickens than for male chickens.

The height of the animal also has a positive and significant (at 5% level) influence on the chicken price. Thus, the poultry price is roughly 14% higher for chicken with long legs (compared to chicken with short legs) and 22% for ducks with long legs (compared to ducks with short legs).

In the same way, the meatiness^40 significantly and positively influences the chicken price (at 1% level), with the poultry price being 30% higher for meaty chicken. Thus, traders have a high willingness to pay for this characteristic, at roughly FCFA 456 per chicken. This result shows that, although consumers have a preference for indigenous poultry, they are more interested in meatier birds. However, the weight, the height and the meatiness of the poultry are related to the breed. For Orden et al. (2005), size/weight and meatiness are manifestations of good breeds. For this reason, efforts must be made to improve local breeds by stressing the characteristics preferred by consumers notably the weight, the quantity of meat and the color of the plumage; this could result in higher returns for poultry keepers. Following Chrysostome and Sodjinou (2005), one of the strategies, which can be used to improve local breeds in Benin is to select among local birds those which have some interesting characteristics, such as the so-called Sahouè chickens (reared mainly in clayey areas in the southern part of Benin), or the Foulani chickens (mainly from the northern part of Benin). The former has short legs and the latter has long legs, but the two are appreciated by producers for their performance (high growth rate, high number of eggs laid per clutch, easy to market, good sale price, meatier and good weight) (Chrysostome and Sodjinou, 2005). This strategy of selection of local breeds is probably the most promising mainly because of the low rate of adoption of the improved cockerels, as noted in section 3.4.4.

Finally, the age of chickens has a positive and significant effect (at 10% level) on the price. Thus, the price of the bird is 13% higher for chickens aged between 6 and 12 months than for older chicken. Hence, traders prefer chickens aged from 6 to 12 months. In other words, traders have the highest willingness to pay for this characteristic, roughly FCFA 202 for chickens aged 6 to 12 months. This result suggests that selling poultry at this age will result in higher returns for the producer, since traders offer a higher price premium for this type of chicken.

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^40 The meatiness of the bird is defined by a well-muscled body which connotes a higher dressing and carcass yield (Orden et al., 2005).
6.7. Conclusion and implications

The objective of this chapter was to assess village poultry market performance and how the market works for the poor village poultry producer, the way their positions can be upgraded, and how changes in market performance may affect them. The results obtained show that there are several middlemen between the producers and the consumers and that the long marketing chain does not allow the former to get good prices for their products. Thus, traders, especially urban wholesalers, are the ones who gain the most on the village poultry market. On other hand, farmers usually sell their products when they are in financial need or because of disease outbreaks. In other words, they are more subsistence oriented, i.e. use poultry as (liquid) savings and insurance.

The analysis of the traders preferred village poultry characteristics indicates that the color of the plumage, weight/meatiness and the bird’s age constitute the main factors affecting prices. Village poultry is also highly appreciated for its taste and the low proportion of fat. This indicates that despite the genetic erosion, which has occurred over the centuries, the local chicken populations still have significant variability, which results in excellent quality meat, but also the preservation of a unique genetic reserve of various characteristics (i.e. color, form, rusticity, etc.). However, although consumers have a preference for indigenous poultry, they are more interested in meatier birds. For this reason, efforts must be made to improve local breeds by stressing the characteristics preferred by consumers notably the weight, the quantity of meat, and the color of the plumage, which would result in higher returns for poultry keepers.
Chapter 7.
General conclusions and implications

7.1. Introduction

Benin is among the poorest countries in the world with an agriculture-based economy. Poverty is more prevalent in rural areas, where village poultry plays a significant role in generating income for many people. Village poultry can be a useful tool for alleviating abject rural poverty and promoting gender empowerment. Recognizing this role, the government and various development agencies have supported the development of village poultry in Benin. Most of the methods implemented by these agencies were at the community level, since the technique of village poultry farming (mainly scavenging) requires initiatives at the community level.

The overall goal of this study was to assess the impact of these poultry-based interventions on the village poultry performance and on the rural households’ living conditions. The specific objectives was to (i) assess the socioeconomic and institutional factors which influence the adoption of village poultry improvement technologies, (ii) evaluate the impact of community-based management on village poultry performance (profitability, poultry survival rate and efficiency) (iii) estimate the impact of poultry-based interventions on rural households’ living conditions (poverty, gender empowerment, income, education), and (iv) analyze village poultry market performance.

The motivation of this chapter is to summarize the main findings of this study and to provide some policy recommendations and advice for future research. The remainder of the chapter provides a synthesis of the data collection (section 7.2) and the main findings (section 7.3). Section 7.4 discusses the policy implications of the research and suggests policy options which can better support village poultry farming and which can guide further efforts for using poultry as a tool for poverty alleviation. Section 7.5 describes the limitations of the research and provides some suggestions for future research.

7.2. Data collection

To achieve the main objective of this study, we used the Sustainable Livelihoods Approach (SLA) to investigate the contribution of poultry-based interventions to rural households’ livelihoods and, more specifically, their potential for increasing village poultry performance through the adoption of various innovations, but also for improving the living conditions of rural households (wellbeing, gender empowerment, reducing vulnerability).

In the southern and northern parts of Benin, one province was selected based on three main criteria: the level of rural poverty, the level of food insecurity and the implementation of poultry-
based interventions in the past ten years. In each province, two districts where poultry-based interventions had been implemented during the past decade were selected. Two categories of villages were considered in each district: two experimental and one non-experimental. Hence, in total, eight experimental villages and four non-experimental villages were selected for the study. In each research village, poultry-keepers’ households were selected using stratified sampling techniques in which the households were first grouped into four classes based on a wealth ranking. In each class, the sample households were made up of participant and non-participant households. The sample consisted of 303 households: 147 participants and 156 non-participants. In each household, all the members who produced poultry were interviewed, as well as all the household members who were old enough to get a loan.

Furthermore, five rural and four urban markets were surveyed. The markets were selected in order to easily follow the dynamic movement of poultry products from rural areas (research sites) to urban/consumption area. A total of 130 village poultry traders were interviewed during two market-days in the rural markets and four market-days in urban markets.

Data were collected through two main steps: exploratory survey and quantitative data collection. The exploratory survey started with discussions with key-informants (researchers, veterinarians, etc.), NGOs, project/program staff involved in village poultry production, and village poultry vaccinators (VPV) in order to understand their perspectives of community-based management and various village poultry production technologies. Two focus groups were established in each research village and semi-structured interviews were conducted with key informants.

During the second step (quantitative data collection), a structured questionnaire was used. The administration of the questionnaire was made possible with the help of eight enumerators, who were given two-days training during which they were introduced to the purpose of the study and its scope. They were then taken through the questionnaire: each question was read and explained, and the aim of the question stressed. Note that during this second step, enumerators were equipped with digital scales for animal weighing, a digital camera and GPS (Global Positioning System) to take the coordinates of each household.

In short, this methodological approach enabled us to reduce biases due to bad sampling and bad data recording.

### 7.3. Main empirical findings

**Factors influencing the adoption of village poultry improvement technologies in Benin**

The first specific objective of this research was to assess the socioeconomic and institutional factors, which influence the adoption of village poultry improvement technologies (vaccination, henhouses, chick-houses, improved feed, and improved cockerels). This was addressed in chapter 3 by using a qualitative choice model (logit) model. The results show that community-
based management results in some changes to the peasant’s behavior concerning the management of village poultry farming. Farmers from experimental village are more aware of poultry vaccination; most of them distribute water to their poultry as well as improving feed. Our results also suggest that decisions concerning the adoption of village poultry technologies primarily depend on access to resources, notably credit. Education also has a positive and significant effect on the adoption of village poultry improvement technologies. Farmers in the South are more likely to adopt improved cockerels, chick-houses and improved feed than those in the North. On the other hand, producers in the North are more likely to adopt henhouses and poultry vaccination than those in the South. This is due to the fact that in the North, producers are more involved in cow rearing where the utilization of vaccination is frequent. The difference between the two regions can also be caused by the difference in the profitability of village poultry vaccination, which is higher in the North than in the South. This is also related to the strategy used in the North where VPVs are organized in associations and also private veterinarians are involved in the supply of vaccines and other veterinary products to VPVs. We also found that village poultry vaccinators (VPV) do not have equipment (for storage of the vaccines) or products (vaccines and antibiotics). Furthermore, some VPVs do not master the timing for poultry vaccination, i.e. they vaccinate birds when some of them are already infected or are already sick with the disease. This poor timing for vaccination increases the death rate amongst several birds, notably chickens. Men are more likely to adopt henhouses than women because they have more access to labor and financial means. Finally, it is worth noting that improved cockerels were not widely adopted due to various reasons; notably that the introduction of new genes had a serious impact on phenotypic diversity, which is highly valued in rural areas. Also, the crossbreed obtained from the first generation was not adapted to the traditional practice of poultry rearing and, consequently, the rate of loss was high, which was mainly due to the birds’ low level of resistance.

**Impact of community-based management on village poultry performance in Benin**

Chapter 4 deals with the second specific objective of this study and evaluates the impact of community-based management on village poultry performance, namely the profitability of village poultry production, determinants of poultry survival rate, technical efficiency, average and marginal product. Various methods were used: enterprise budget (for profitability analysis), censored regression (for poultry survival rate analysis) and stochastic frontier analysis (efficiency assessment). Village poultry is profitable for participants as well as non-participants in CBM. The annual incomes from village poultry are greater for participants in the CBM than for non-participants. Similarly, the average productivity of parents, labor and vets are higher for participants in CBM than for non-participants. Also, non-participants in experimental villages have higher incomes from poultry production than non-participants in non-experimental villages.

The return over variable costs per kilogram of chicken produced is higher for female participants in CBM than for men. The same trend is noted amongst non-participants in CBM: women have
higher returns over variable costs than male producers. These results imply that despite the low access to labor and financial means, women achieve a higher profit per kilogram of chicken produced than men in village poultry production. Also, for the participants in CBM, the average productivity of parents achieved by women is higher than that achieved by men. Similarly, for the participants in CBM, women’s marginal product is almost the same as men’s, despite having reduced access to credit and labor. In fact, in some cases (e.g. vet and labor), women achieve a higher productivity than men.

The main factors in decreasing order, which influence the village poultry survival rate, are henhouses, improved feeds and vaccination. In other words, the construction of a henhouse is the most important factor if one wants to develop traditional poultry farming. Once the birds are sheltered, the development of feeding and vaccination should follow. Also, there is no doubt that the provision of Newcastle Disease vaccines and other animal health services can improve the productivity of village poultry.

Also, an inefficiency effect exists amongst village poultry breeders, which means that there is room to increase village poultry output, given existing technology. Educated farmers seem to be more efficient in village poultry production than non-educated farmers. Finally, community-based management has a positive effect on breeders’ efficiency not only for participants in CBM, but also for non-participants in experimental villages.

Impact of poultry-based interventions on rural households’ living conditions

The fifth chapter is concerned with the estimation of the impact of poultry-based interventions on rural households’ living conditions. For this purpose, five different treatments were defined: the control group, households that received microfinance alone, households that only participated in community-based management (CBM, the technical part of poultry-based interventions), households that participated in CBM and PBM (poultry-based microfinance, i.e. microfinance formally granted for poultry production), and households that participated in CBM and NPBM (non-poultry based microfinance, i.e. microfinance not formally granted for poultry production).

Given the non-experimental nature of the data set used in the work, the problem of selection bias needed to be addressed using a multiple treatments propensity score matching. All the treatments were compared to the control group. Three indicators (bias reduction, pseudo $R^2$ and log-likelihood ratio test) were used to examine the extent to which the propensity score balanced the distribution of covariates across treatment and control groups. All in all, there was no significant difference in the distribution of the covariates (between treated and control group) after matching. The main finding was that CBM and microfinance used separately, or in combination, positively improved participant households’ income from poultry production and helped them to move from a subsistence-oriented logic to a more economic or market-oriented logic. CBM positively and significantly improved the wellbeing of the participant households. This improvement is more significant when the participants in CBM receive poultry-based
microfinance, i.e. microfinance granted formally for village poultry production. On the other hand, the use of microfinance alone (i.e. without CBM) did not significantly improve the wellbeing of the recipient households. CBM can only reduce poverty among the poorest households, but without the addition of poultry-based microfinance, participant households cannot escape poverty. Moreover, women from the recipient households increased their control of resources, i.e. there was an increase in women’s participation in decision-making within their households. In short, our results confirm the fact that village poultry is a tool for poverty reduction especially among the poorest. However, this will only help recipients move out of poverty if the technical support is combined with poultry-based microfinance, which is needed for the adoption of village poultry improvement technologies (vaccination of poultry, henhouse building and improved feeding). To sum up, our study agrees with Dolberg (2003), in that it is possible to design livestock projects, especially village poultry-based project, that allow poor people to obtain basic skills which can help them escape poverty.

Analysis of the performance of village poultry market

In chapter 6, we assess the village poultry market performance and how the market works for the poor village poultry producers. The results obtained show that the marketing of village poultry is the domain of women in the South and the domain of men in the North of Benin. In general, village poultry marketing channels are complex and informal, with several middlemen between the producers and consumers. This means that the producers do not receive a high enough price for their products because the marketing costs are higher as there are many intermediaries involved between the smallholder producers (who are widely dispersed) and the consumers who are located several hundred kilometers away. Thus, traders, especially urban wholesalers, are the ones who gain the most in village poultry market. On the other hand, farmers usually sell their products when they are in financial need, or when disease breaks out in their flock. Village poultry traders gain large marketing margins in their activity. This can be due to poor infrastructure, namely transportation and communication, which gives rise to large marketing margins because of the high costs of delivering products to destinations. There is also an urgent need to strengthen market information delivery systems, to upgrade roads in rural areas, to encourage market integration initiatives, and to establish more retail outlets with improved market facilities in the remote rural villages in order to promote production and trade in high value commodities by rural farmers. The analysis of the traders’ preferences for village poultry characteristics indicates that the color of the plumage, weight/meatiness and the bird’s age constitute the main factors which affect prices. Village poultry is also highly appreciated for its taste and the low proportion of grease. This indicates that despite the genetic erosion, which has occurred over the centuries, the local chicken population is still characterized by a sufficiently significant variability, which ensures excellent quality meat and the preservation of a unique gene reserve of various types and characteristics (i.e. color, form, rusticity, etc.). However, although consumers have a preference for indigenous poultry, they are more interested in the meatier birds.
7.4. Policy implications

In the various analyses carried out in the previous chapters and summarized above, we have shown that poultry-based interventions improve the living conditions of rural households. These improvements were achieved through the adoption of various technologies often used in intensive poultry rearing (vaccination, housing, improved feeding, etc.). The adoption of these technologies is determined by producers’ access to credit. Vaccination was the major factor in the improved poultry survival rate. In total, these results allow us to formulate the following recommendations concerning the use of poultry as a tool for poverty reduction and gender empowerment.

- **Improvement of poultry survival rate (i.e. reduction of poultry mortality rate)**

The first activity, on which one should focus, is to reduce the poultry mortality rate. The main strategies to achieve this is to promote village poultry vaccination and to support the adoption of best management practices for livestock including the construction and maintenance of henhouses, the provision of nutritional supplements for birds, good follow-up of birds (early detection of sick birds, choice of the right marketable age for birds, etc.) and henhouse cleaning. The adoption of these practices/technologies requires producers’ awareness of their existence, but also that they have access to them. In order to achieve a more efficient approach, it must be based on the community in order to sustain the actions undertaken. In short, the government or development actors must invest in the dissemination of information regarding village poultry improvement through a community-based approach in particular.

Furthermore, the use of improved feeding has a negative and significant effect on the survival rate of chickens. According to the producers interviewed, this situation can be explained by the fact that chicks are frequently killed by ants, shrews and snakes (in particular during the night) when the small birds are sheltered without special care (e.g. use of carbide from weld to surround the shelter). The main implication of this finding is that, in the use of poultry as a tool for poverty reduction, the use of supplementary feeding (i.e. the use of improved feed) should be emphasized in order to improve the birds’ survival rate and their performance.

- **Access to credit**

Access to credit is the second strategy to support if one really wants to use poultry as a tool for poverty reduction. Indeed, the poultry activity is to be considered as a learning process for the beneficiaries, but it should be noted that one activity alone is insufficient to lift a family out of poverty. Credit is required to finance working capital and to invest in fixed capital, particularly henhouse construction. Access to credit will also enable small-scale farmers to adopt innovation and use improved husbandry practices, such as improved feeds, veterinary services, etc. The
main policy implication is that it might be important for the government or development actors to improve the access to credit for farmers, especially women. The credit granted must be strictly oriented towards poultry farming: mainly used for henhouse construction. It is desirable that the repayment of this credit starts about six months after it has been granted to give the farmers time to produce their first marketable products.

- **Training and installment of village poultry vaccinators’ (VPV) networks**

For the actions proposed above to be sustainable in the long-term, there is a need to install and train VPVs: those who are available should be trained frequently, and new VPVs should be installed in villages, where VPVs are lacking. These VPVs must come from the community and should be equipped, after their training (on vaccination against Newcastle disease, and husbandry practices), with basic facilities for the conservation of veterinary product (icebox, syringe, and, if possible refrigerator in villages where electricity is available). The organization of VPVs in a network in each district and especially the involvement of private veterinarians (approved by the State) will facilitate the efficient supply of VPVs with veterinary products.

- **Breed improvement**

Consumers prefer indigenous poultry (especially those with a lot of meat and good weight) to crossbreeds. For this reason, efforts must be undertaken to improve local breeds by stressing the characteristics preferred by consumers notably the weight, the quantity of meat and the color of the plumage, which might result in higher returns for poultry keepers. One of the strategies that can be used to improve local breed in Benin is to select, among local birds, those which have some interesting characteristics, such as the so called Sahouè chickens (reared mainly in clayey areas of the southern part of Benin), or the Foulani chickens (mainly from the northern part of Benin). The former has short legs, whilst the latter has long legs, but the two are appreciated by producers due to their performance (high growth rate, high number of eggs laid per clutch, easy to market, good selling price, meatier, and good weight).

- **Access to market**

Efficient marketing is an essential prerequisite for successful small-scale enterprises. Broadcasting market information by radio can help rural farmers to obtain fair prices for their poultry products.

- **Required change in peasant behavior**

Traders prefer chickens from 6 to 12 months, which is the best marketable age. In other words, traders have the highest willingness to pay for this characteristic, and they will pay roughly FCFA 202 more for a chicken which is 6 to 12 months than for an older chicken. This result suggests that producers will receive higher returns if he can sell his poultry at this age.
Having a chick-house has a negative and significant influence on the survival rate of chickens and chicks, mainly due to the flock management practice of the breeder (feeding of chicks in chick-house, low frequency of chick-house cleaning, etc.). The main implication of this result is that breeders should clean their chick-house more frequently, especially after feeding, in order to avoid food scraps attracting predators, or they should feed chicks outside the chick-house.

- **Organization of producers**

Another constraint to up-scaling poultry production for livelihood improvement and poverty alleviation is institutional and organizational. Indeed, as stated by Dolberg (2003), it is poor women and their families who run the smallholder poultry production system, but they are not organized and most government veterinary and extension systems do not reach out to them. They are, therefore, left in an organizational vacuum with poor guidance from the national governments. Our work indicates that community-based management (as poultry ‘interest group’) has various effects on individual participant, their household and the community. Activities that encourage community participation and group formation will promote the establishment of sustainable programs.

### 7.5. Limitations of the research and recommendations for further investigation

Our study has some shortcomings that should be emphasized in order to suggest tracks for future research. Firstly, our study is mainly based on cross-sectional data. The fundamental limitation of this type of data, for instance in adoption studies, is that they do not allow for an in-depth analysis of the dynamics of technology adoption. For this reason, we suggest the collection of panel data for future research.

Second, concerning the adoption of various poultry improvement technologies, we based our work mainly on individuals who currently use the technologies. In other words, we did not carry out a dynamic analysis of adoption: an analysis of those who adopted the technology at the beginning, but have abandoned it, those who have always used the technology, those who did not use them at beginning, but later began to use them, etc. Indeed, although village poultry improvement technologies are successful, other technologies introduced in the same area have been without success. For instance, surveys carried out by Adegbola (2010) show that 73% of farmers who initially adopted Sofagrain® went on to abandon it. The early identification of reasons for abandoning technologies can help sustain the use of these technologies. In the same way, the identification of the differences in the characteristics of those who abandon a technology and those who do not adopt it, may increase understanding of the obstacles to initial

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41 The symbol ® stands for ‘Registered trade mark’. Sofagrain, constituted of 0.2% Delmethrin and 1.5% Pyrimiphos-Methyl, is an insecticide used to control pests in stored grains, notably cereals and leguminous
adoption of a technique. We recommend a dynamic analysis for future research on the adoption of village poultry technologies.

Third, in the evaluation of the impact of poultry-based intervention, we assumed homogeneity in the participation in CBM, in microfinance programs or in both CBM and microfinance program. However, among the participants in CBM, there is heterogeneity, in so far as certain breeders only adopted vaccination, whilst others only adopted housing, or improved feed, whilst others adopted a combination of the two or several of these technologies. This heterogeneity can lead to different effects. Thus, it follows that future studies should take this heterogeneity into account in order to improve the evaluation of impact of poultry-based interventions.
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StataCorp, 2007. Stata Statistical Software: Release 10. College Station, TX: StataCorp LP.


Appendices
Summary

Benin is among the poorest countries in the world with an agriculture-based economy. Poverty is more prevalent in rural areas where, for many people, village poultry plays a significant income generating role. The important position of village poultry in the national meat supply (second most popular source of meat after beef) and in the household’s income suggests that poultry can be a useful tool in alleviating abject rural poverty and in gender empowerment. In recognition of this role, the government and various development agencies have supported the development of village poultry in Benin. The projects implemented for this purpose constitute two parts: a technical component (CBM: community-based management) and a financial component (microfinance). The overall goal of this study is to assess the impact of these poultry-based interventions on the village poultry performance and on the rural households’ living conditions. The specific objectives are (i) to assess the socioeconomic and institutional factors which influence the adoption of village poultry improvement technologies, notably henhouses, poultry vaccination and improved feeding, (ii) to evaluate the impact of CBM on village poultry performance (profitability, poultry survival rate, technical efficiency), (iii) to estimate the impact of poultry-based interventions on rural households’ living conditions (poverty, vulnerability, gender empowerment, education), and (iv) to analyze village poultry market performance.

Methodologically, the work is based on the Sustainable Livelihood Approach as a general analytical framework to analyze how poultry-based interventions contribute to the livelihood of rural households. Data used were collected in eight experimental villages and four non-experimental villages selected in four districts of Benin, through three main steps: pre-study (literature review and secondary data collection), qualitative survey, and quantitative data collection. In each research village, poultry-keeping households were selected by using stratified sampling techniques in which households were first grouped into four classes based on a wealth ranking. In each class, the sample-households were made up of participant households and non-participant households. The sample size constitutes of 303 households: 147 participants in CBM and 156 non-participants. In each household, all members who produce poultry were interviewed as well as all household members who were old enough to get a loan. Furthermore, 130 village poultry traders were interviewed in five rural and four urban markets. After the field work, the questionnaires were checked and codified. Data were recorded with Microsoft Access software. Then, depending on the specific objectives, various econometric tools were used.

For the first specific objective (i.e. assessment of the socioeconomic and institutional factors which influence the adoption of village poultry improvement technologies), logistic regression was used. The adoption of village poultry technologies primarily depends on access to resources, notably credit (cf. chapter 3). It also depends on the availability of village poultry vaccinators (VPVs), and breeders’ experience (education level and participation in CBM). Farmers from experimental villages are also more willing to adopt various village poultry improvement technologies such as vaccination, improved feed, henhouses, and chick-houses. This indicates
that when farmers have the information and technical support through an approach based on the community, i.e. CBM, they can change their behavior, overcome traditional ways of poultry farming and achieve increased profits. Furthermore, the adoption of the technologies is successful when the strategies used are based on the involvement of private veterinarians for the supply of VPVs in vaccines and other veterinary products.

Second, using the enterprise budget approach (chapter 4), we found that village poultry is profitable for participants, as well as for non-participants in CBM. The annual revenues from village poultry are greater for participants in the CBM than for non-participants. Similarly, the average productivity of parent animals, labor and vet are higher for participants in CBM than for non-participants. Also, non-participants of experimental villages have higher revenues from poultry production than non-participants of non-experimental villages. We also found that, despite the low access to labor and finance, women attain a higher profit per kilogram of chicken than men in village poultry production. Also, for the participants in CBM, the average productivity of parent animals is higher for women than for men. In the same way, for the participants in CBM, women have a marginal product which is almost equivalent to that of men, and in some cases (e.g. vet and labor) the productivity is actually higher for women than for men.

Third, using censored regression (chapter 4), the main factors which influence the village poultry survival rate are, in decreasing order, henhouses, improved feed, and vaccination. In other words, the construction of henhouses is the most important factor if one wants to develop traditional poultry farming. Once birds are sheltered, the feeding and vaccination should follow. Also, there is no doubt that vaccination against Newcastle Disease and other animal health services can improve the productivity of village poultry.

Fourth, based on a stochastic frontier translog production function (chapter 4), the study showed that an inefficiency effect exists amongst village poultry breeders, which means that there is room to increase village poultry output, given the existing technology. Educated farmers and those living far from markets seem to be more efficient in village poultry production than non-educated farmers and those living near markets. CBM has a positive effect on breeders’ efficiency, not only for participants in CBM, but also for non-participants of experimental villages.

Fifth, the study applies the multiple treatments propensity score matching method (chapter 5) to assess the impact of CBM (technical part of poultry-based interventions), the impact of microfinance (financial part of poultry-based interventions), and the impact of the combination of both. Our main finding is that CBM positively and significantly improves the wellbeing of the participant households: higher income from poultry production, improvement of their market orientation logic, reduction of poverty and poverty gap, and gender control over resources. This improvement seems to be more pronounced when the participants in CBM receive poultry-based microfinance, i.e. microfinance for village poultry production. On the other hand, the use of microfinance alone (i.e. without CBM) does not significantly improve the wellbeing of the
recipient households. Our results also confirm the fact that village poultry can be a tool for poverty reduction especially among the poorest. However, this will help recipients move out of poverty only if the technical support through community-based management is combined with poultry-oriented microfinance. Technical support for village poultry has the power to reduce not only significant poverty incidence, but also the poverty gap and the severity of poverty. The addition of microfinance allowed the farmers, whose incomes were close to the poverty line, to escape from poverty. In other words, village poultry production may be used as a starting point for helping the poor to make the first step out of poverty, but poultry alone may not be adequate to get every poor household out of poverty.

Finally, the structure-conduct-performance approach and hedonic price (chapter 6), were used to analyze the village poultry market performance. The results show that there are several middlemen between producers and consumers and that the long marketing chain does not allow the former to get remunerative prices for their products. Thus, traders, especially urban wholesalers, are the main gainers in the village poultry market. On the other hand, farmers usually sell their products when they are in financial need or because of disease events. In other words, they use poultry as (liquid) savings and insurance rather than as a source of regular income. The analysis of the traders’ preferences for village poultry characteristics (using hedonic price model) indicates that the color of the plumage, weight/meatiness, and bird’s age constitute the main factors affecting their prices. Village poultry is also highly appreciated for its taste and the low proportion of fat. This indicates that despite the genetic erosion, which has occurred over the centuries, the local chicken populations still have significant variability, which results in excellent quality meat, but also the preservation of a unique genetic reserve of various characteristics (i.e. color, form, rusticity, etc.). However, although consumers have a preference for the indigenous poultry, they are more interested in meatier birds.

In short, our results confirm that village poultry is a useful tool for poverty reduction especially among the poorest. However, this will help recipients move out of poverty only if the technical support (that relies on the community) is combined with poultry-based microfinance. The latter is needed for the adoption of village poultry improvement technologies (vaccination of poultry, henhouse building, and improved feeding). Furthermore, for the development of the traditional poultry farming as an income generating activity, bird’s housing is an important factor to target. Also, using supplementary feeding (i.e. the use of improved feed) should be emphasized in order to improve not only birds’ survival rate but also their performance.
List of research period activities

- **Courses**

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- **Presentation at seminars and workshops**

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<td>Poultry-based interventions as tool for poverty reduction and gender empowerment: Empirical evidence from Benin</td>
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- **Other research works co-authored during the project period**


Curriculum vitae

Epiphane SODJINOU was born on January 06, 1973 in Adjarra, Ouémé province, Benin. He attended primary school at Ko-Koumolou (commune of Ifangni, Plateau province). He continued the first years of his middle high school at Tchaada Secondary School and moved to Sakété secondary school (Plateau province) where he obtained the middle high school diploma (BEPC). Next, he continued the first years of senior high schools at Dassa-Zoumé (Collines province) before moving to Porto-Novo where he completed high school at Davié, with a Benin national high-school diploma (Bac C). In 1994, he earned a Benin government scholarship to join the Faculty of Agricultural Sciences, University of Abomey-Calavi (Benin), where he obtained the degree of “Ingénieur Agro-économiste” (Engineer in Agric-Economics). Thereafter, he served as a Research Assistant at the Department of Economics, Socio-Anthropology and Communication (DESAC/FSA/UNB) from March through September 2000. He holds an MSc degree in Biostatistics (“Informatique et Statistique appliquées”) obtained after joining, from September 2000 to October 2001, the Faculty of Agricultural Sciences of Gembloux (FuSAGx, Belgium) with the financial support of the CUD (Coopération Universitaire au Développement, Belgian Cooperation). From October 2001 through February 2002, he worked as Research Assistant in the project COS (Convergence des Sciences), Faculty of Agriculture, University of Abomey-Calavi. Since September 2002, he is junior agricultural economist researcher at Agricultural Policy Analysis Unit (PAPA) of the National Agricultural Research Institute of Benin (INRAB). In the course of his assignment, he has been involved in various research works, report writing and article publication. In 2007, he was awarded a grant from the Danish International Development Agency (DANIDA) through the second phase of Benin Agricultural Sector Development Support Program (PADSA II). In March 2008, this grant gave him the opportunity to join, the Applied Economic (AECON) School of the Institute of Food and Resource Economics, Faculty of Life Science, University of Copenhagen (FOI/LIFE/KU) as Ph.D. student.

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