FACTORS INFLUENCING NEWCASTLE DISEASE VACCINE
BIOTECHNOLOGY ADOPTION BY SMALL-HOLDER POULTRY
FARMERS IN KATHIANI AND CENTRAL DIVISIONS OF
MACHAKOS DISTRICT, KENYA.

BY

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AUGUST 2005
DE CLARA

I hereby declare that this thesis is my original work and has not been presented for an award of degree or any other award in any other University.

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DEDICATION

To my beloved grandmother, Hellen Saida, and wife, Treza Awino

[Text continues with acknowledgments and thanks to various individuals and organizations for their support and contributions to the work.]
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<td>African Biotechnology Stakeholders’ Forum</td>
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<td>ACC</td>
<td>Administrative Committee on Coordination</td>
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<td>ACIAR</td>
<td>Australian Center for International Agricultural Research</td>
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<tr>
<td>BNF</td>
<td>Biological Nitrogen Fixation</td>
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<td>CBO</td>
<td>Community Based Organization</td>
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<td>cDNA</td>
<td>Chromosomal Deoxyribonucleic Acid</td>
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<td>CSA</td>
<td>Center for the Study of Adolescents</td>
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<td>DLEO</td>
<td>Divisional Livestock Extension Officer</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>FGD</td>
<td>Focus Group Discussion</td>
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<td>FPR</td>
<td>Farmer Participatory Research</td>
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<td>ISAAA</td>
<td>International Service for Acquisition of Agricultural biotechnology Applications</td>
</tr>
<tr>
<td>KARI</td>
<td>Kenya Agricultural Research Institute</td>
</tr>
<tr>
<td>KEVEVAPI</td>
<td>Kenya Veterinary Vaccine Production Institute</td>
</tr>
<tr>
<td>LEIA</td>
<td>Low External Input Agriculture</td>
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<tr>
<td>MIRCEN</td>
<td>Microbiology Resource Center</td>
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<tr>
<td>MoLD</td>
<td>Ministry of Livestock and Development</td>
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<tr>
<td>MPHE</td>
<td>Master of Public Health and Epidemiology</td>
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<tr>
<td>NCD</td>
<td>Newcastle Disease</td>
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<td>NCDV</td>
<td>Newcastle Disease Vaccine</td>
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<td>NCST</td>
<td>National Council of Science and Technology</td>
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ABSTRACT

FACTORS INFLUENCING NEWCASTLE DISEASE VACCINE BIOTECHNOLOGY ADOPTION BY THE SMALL-HOLDER POULTRY FARMERS IN KATHIANI AND CENTRAL DIVISION OF MACHAKOS DISTRICT, KENYA.

Agricultural biotechnology, of which poultry vaccine production is an integral component, is believed to hold great potential for contributing significantly to household food security particularly among the small-holder farmers in developing countries such as Kenya. In view of this, developing countries are adopting agricultural biotechnology and Kenya has so far embraced various aspects of this technology including tissue culture planting materials and use of vaccines against livestock/poultry diseases. This descriptive cross-sectional study therefore sought to investigate the factors influencing adoption of the Newcastle disease vaccine, a product of agricultural biotechnology, in Kathiani and Central Divisions of Machakos district where the vaccine was introduced by the Kenya Agricultural Research Institute (KARI) in 1998. A sample size of 150 poultry farmers, most of them small-holder farmers, was determined. The two study areas of Kathiani and Central divisions of Machakos District were selected purposively because KARI, the sponsor of this study, needed data from these divisions for future biotechnology programming. Systematic sampling methodology was then used to identify households in each of the five locations of the two divisions from which respondents were selected and interviewed through interviewer-administered questionnaire. The study established that Newcastle disease (NCD) vaccine adoption was poor since the majority (147; 98%) of small-holder farmers interviewed could not afford it each time they wanted to vaccinate their birds. Similarly, due to limited awareness regarding the importance of vaccine use, many (123; 82%) small-holder farmers interviewed did not know of its availability in the study areas. This, in turn, resulted in the vaccine’s poor adoption rates by the said farmers. The difference between the levels of awareness and unawareness of the vaccine among respondents was significant ($\chi^2_{1} = 61.440; P< 0.001$). Only 3 (2 %) of the respondents who knew about the vaccine used it. The difference between these respondents and those who did not use it (147; 98%) was also statistically significant ($\chi^2_{1} = 138.240; P < 0.001$). The study established that there were no distribution arrangements of the vaccine in the study area to specifically address the needs of the small-holder poultry farmers. This too, contributed to poor adoption of the vaccine by the farmers. In conclusion, unaffordability, low awareness levels as well as lack of distribution strategies for NCD vaccine contributed to its poor adoption levels in the study area. Therefore, the biotechnology intervention (NCD vaccine) may not have contributed to significant increase in household poultry production in the area. There is need to address the reported factors such as low awareness, unaffordability and lack of distribution strategies of NCDV that are constraining NCD vaccine biotechnology adoption by small-holder poultry farmers in order for the technology to contribute to household poultry production in the study area. A rise in poultry production would in turn contribute to household food security through increased consumption of chickens as well as proceeds from the sale of birds, thus increasing family incomes.
CHAPTER 1

INTRODUCTION

1.1 Definition, Scope and Potential Benefits of Biotechnology

Biotechnology is broadly defined as any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use (Persely and Doyle, 1999). It ranges from traditional biotechnology such as fermentation to the most advanced modern biotechnology such as genetic engineering. Biotechnology is not a separate science but rather, a mixture of disciplines (genetics, molecular biology, embryology, and cell biology, among others) converted into productive processes by linking them with such practical disciplines as chemical engineering, information technology and robotics (Persely and Doyle 1999). Biotechnology has the potential to increase crop and livestock production through; improvement of nutritional quality, broadening the tolerance of crop to drought, salinity and other abiotic stresses; increased resistance of crops and livestock to pests and diseases respectively. The potential benefits, in turn, translate into increased food production hence alleviating food insecurity (Doyle and Persely, 1996).

1.2 The Economic Importance, Biology and Control of Newcastle Disease

Despite the introduction of exotic chickens in the 1920s, indigenous chickens still remain dominant in developing countries (Mopate and Lonny, 1998). In Kenya, the indigenous breed represents 74% of the total number of chickens (RoK, 2001). According to Roberts (1992), village chickens can break the vicious cycle of poverty, malnutrition and disease. Chicken meat is rich; nutritionally providing proteins, fats, minerals and vitamins.
Indigenous chickens can be a good source of cheap nutrition for the resource poor households, the sick, malnourished and children under the age of five (Kitalyi, 2002; personal communication). Over 90% of the rural households in Kenya keep and rear indigenous chickens usually in small flocks of about 20 birds (Ndewa et al., 1999; Mbugua, 1990; MoLD, 1990; Stotz, 1983) and more than 80% of the total poultry population in Africa is kept in rural areas (Gueye, 2000).

In the rural areas of Mozambique where two thirds of the population lives in absolute poverty, improving the production of family poultry has been started to promote poverty alleviation and food security (Alders et al., 2002). In many villages, chickens suffer very high mortality (Aini, 1990; Pandey, 1992) due to causes that are largely preventable (Wilson et al., 1987). Newcastle disease (NCD) is known to be the major cause of mortality in indigenous chickens in Africa and Asia (Bell, 1992; Mavale, 1995). To harness the potential of village chickens, Kitalyi (1998) suggested a new approach, aimed at increasing flock productivity through improved extension services, farmer training and preferential treatment of chicks. In this regard, family poultry development in Mozambique therefore focuses on the control of Newcastle disease in rural areas, the distribution of cross-breed chickens and the production of broilers in pre-urban areas of the capital city of Maputo (Mavale, 1995).

NCD or avian paramyxovirus 1 (Alexander, 1997) is the most important avian disease and can result in substantial loss to the poultry industry. It has a wide host range infecting 27 out of the 50 orders of the birds (Jorgensen et al., 1998; Kuiken et al., 1998, Shelling et al., 1999 and Alexander, 2000). The virus is transmitted via inhalation or ingestion and causes a disease of variable clinical severity and transmissibility depending on its
pathotype. NCD outbreaks are common around the world and based on the severity of the disease, the virus can be grouped into three pathotypes; the *lentogenic* strains which cause only clinically mild or latent respiratory disease. The *mesogenic* strains produce respiratory and nervous signs with moderate mortality, and *viscerotropic* or *neutropic* *velogenic* strains cause severe intestinal lesions or neurological disease resulting in high mortality of up to 100% in chickens (Alexander, 1989, 1997). Signs seen in chickens with NCD are gasping, stretching of neck, sneezing, coughing, tracheal rales, dyspnea, opisthotonus, torticollis (Fatunmbi and Adene, 1979), convulsions, trembling of the head and neck, backward movement, weakness or paralysis of the legs (Fatunmbi and Adene, 1979), ruffled feathers, oedema of the head, cloudy eyes, conjunctivitis, severe depression, yellow and whitish diarrhoea, dehydration, emaciation, prostration and sudden death. Turkeys have tracheal rales, showered circling, in coordination, weakness or paralysis of the legs and wings, profuse yellowish, greenish or whitish diarrhoea, ruffle feathers, inability to fly or falling while in flight, conjunctivitis, anorexia, diarrhoea and sudden death were the signs seen in affected guinea fowls (Abdu and Sa’idu, 1990). At necropsy the following lesions are seen in chickens; hemorrhages in the leg and breast muscles, caecal tonsils, rectum, duodenum, trachea, abdominal and coronary fat, and in Bursa of Fabricious, among others. Although the virus is currently controlled or avoided by vaccination or mass slaughtering, it remains a potential threat to commercial or backyard poultry production as was proven by the recent outbreaks in Australia and Malaysia resulting in virtual eradication of birds in outbreak areas (Westbury, 2001).
NCD is effectively controlled through vaccination by the NCD vaccine (Beard, 1979). In Vietnam, the government has encouraged the farmers to participate actively in vaccination campaigns against the major infectious diseases of poultry, the most important of which is NCD (Garforth, 1998). Generally, the incidence of Newcastle disease in village chickens depends mainly on the availability of the vaccine and the capacity of villagers to use it properly. The use of Newcastle Disease Vaccine for prevention of infectious diseases in poultry has been increasing in Vietnam due to effective extension service activities and awareness creation campaigns. As a result, incidences of Newcastle disease have decreased sharply while chickens population has increased rapidly in many villages (Garforth, 1998)

1.3  Factors influencing the adoption of Biotechnology

1.3.1 Public-Private Sector Linkage in technology transfer

The capacity of any biotechnology to enhance food security either at national or household level in developing countries and elsewhere often depends on its level of adoption. Studies indicate that linkages between public sector Research & Development (R&D) and private sector highly promote technology adoption by end users (Erbisch, 2002).

Komen and Persely (1993) reported the need to exploit public – private sector collaboration in promoting adoption of biotechnology at grass-root level in Kenya. Agri-biotechnology R & D projects conducted with a component that facilitates adoption at the grass-root level by the end users have generally registered a significant degree of
adoption. For instance, Wakhusama and Kanyi (2002) reported significant adoption level of clonal tree biotechnology through the involvement of the private sector in the transfer of technology to end-users. Similarly, Komen and Persely (1993) had earlier on reported that lack of technology transfer mechanisms in Kenya was the reason why many biotechnology research products have largely been confined to laboratories. Other studies also indicate that most other developing countries are currently designing projects with mechanisms to transfer the technology to end-users. For instance, Malaysia has made attempts to enhance technology transfer from research laboratories to industry and finally to resource poor farmers by establishing an Industrial Development Unit to specifically deal with that (Komen and Persely, 1993).

In Costa Rica, product distribution channels and agricultural extension in the public sector to reach farmers’ fields have been responsible for the process of change towards privatization to enhance access of biotechnologies by the resource poor farmers (Spillane, 1999). Available data also indicate that in Brazil and China, one of the challenges faced in agri-biotechnology developments is the transfer of technology to the farming populations (Persely and Lantin, 2000). Although China had put in place a network system to dispense agricultural technologies, seeds and other related materials, that could be eroded following the advent of market economy (Persley and Lantin, 2000).

1.3.2 Policy Framework
Favorable policy environment is a requisite condition for exploitation of the potential of agri-biotechnology R & D. According to Carrere (1979), technology development has two very important components namely; the promotion of domestic capacity for
production, dissemination and application of technologies and, orientation and selective control of technology transfer. Lack of enabling policy environment has been a major setback to the adoption of biotechnology in many African countries including South Africa (Erbisch, 2002). Africa particularly needs policies that support agri-biotechnology research, development and commercialization of research products (Erbisch, 2002). The need for policy framework to guide and support science and technology in Kenya was identified as a requisite condition for the country's development as early as 1980. The National Council of Science and Technology (NCST)'s 1980 report on Technology Policy put more emphasis on the development and spread of new technologies in rural areas. The policy recommended that research findings be made available to farming communities with minimum delay and time lapses and research results be verified for faster adoption. The policy further recommended that conventional and professional schools, extension service and mass media be used to inform rural populations about possibilities for higher incomes, more employment and better livelihoods offered by technological innovation. Despite this, technology transfer in Africa still remains poor (Erbisch, 2002). Available data indicate that there is no policy framework guiding biotechnology R & D in many African countries including Kenya. Studies further indicate that under such circumstances the resource poor farmers may not benefit from agricultural biotechnology. Leisinger (1999) argues that unless developing countries have policies in place to ensure that small scale farmers have access to delivery systems, extension services, productive resources, markets and infrastructure, there is considerable risk that the introduction of agricultural biotechnology could lead to inequitable distribution of wealth and incomes. In such a case, large-scale farmers are likely to
capture most of the benefits through early adoption of technology, expanded production, and reduced unit costs.

Generally, there has been little incentive for farmers to invest in new technologies or in other agricultural enterprises (Persley and Lantin, 2000). The low profitability has encouraged low productivity, low risk avoidance measures including multiple cropping, minimum in-put uses, and extensive agricultural activities based on human labour (Persely and Lantin, 2000). The welfare of farmers is further reduced by direct and indirect taxes on their exports as well as by distortion of international market prices brought about by heavy subsidies in developed countries (Persley and Lantin, 2000). Policy measures that remove such disincentives and promote productivity are needed (Leisinger, 1999; Erbisch, 2002). Many developing countries including Kenya are at different stages of developing biotechnology policies to guide their biotechnology R & D activities. The need for an appropriate policy framework to hasten development of biotechnology R&D in Kenya cannot be overemphasized.

1.3.3 Awareness Creation and Distribution of Biotechnology Products and Processes

Awareness creation and dissemination are very important components of technology transfer. A study by Qaim (1999) on the impact of Tissue Culture Banana biotechnology adoption in Kenya recommended the need for enhanced awareness creation accompanied by efficient distribution channels. Similarly, Emongor et al. (1999) in a feasibility study on animal health biotechnology project in Machakos and Kakamega Districts of Kenya recommended an efficient awareness creation and distribution of biotechnologies existing in the area. Available data indicate that awareness creation, as part of marketing strategy
of the biotechnologies, plays an important role of informing the target population groups about the availability of the said technologies. For instance, the Office of Intellectual Property at Michigan State University in the United States of America, talked to people in order to create awareness through seminars and talking to departmental heads in a bid to inform the target population about the availability of the University’s new technologies, and hence advises other institutions involved in biotechnology R & D to follow suit (reviewed in Regulations and Guidelines for Safety in Biotechnology for Kenya; 1996). Although there is potential for distribution of biotechnology using local NGOs, this has not been exploited (Emongor et al., 1999). Consequently, many biotechnology products remain confined to laboratories (Komen and Persely, 1993).

Lack of awareness creation has also been reported in many other agri-biotech R & D initiatives. For instance, low inoculant (bio-fertilizer) adoption was reported among many farmers despite its confirmed comparative advantage over conventional chemical fertilizers. In a survey carried out in Kiambu District of Central Province where 52 farmers were visited, 95% grew beans but of these only 5% had some knowledge of rhizobia inoculants (Keya et al., 1981). In another survey carried out in 1996 in Kisii and Kakamega Districts by MIRCEN project staff, it was found that the state of awareness had not changed at all over the 15 years since the introduction of the inoculants as only 20%-40% of the farmers interviewed knew about Biological Nitrogen Fixation (Bio-fertilizer inoculant) biotechnology. Even worse, only 2% had used inoculants in Kisii & Kakamega (MIRCEN – UNEP 1995). Clearly, the limited awareness had led to poor technology adoption by the target small-holder farmers. The same study established that
lack of availability of the rhizobia inoculants close to the farmers was another contributing reason why there was low technology adoption (MIRCEN-UNEP; 1995)

1.3.4 Poverty

In some parts of Kenya, poverty is defined as the inability of the families to meet their basic needs such as food, clothing, housing, health and education for the children (Machakos District Development Planning Unit, 2002-2008). Qaim (1999) reported that socio-economic status played an important role in determining biotechnology adoption by small-holder farmers. Between 55% and 60% of rural people in sub-Saharan Africa are absolutely poor, subsisting on less than U.S. $1 per day and more than 200 million people (over one-third of the African Population) suffer chronic undernutrition (Persely and Lantin, 2000). Most African populations spend over 80% of their earnings on food leaving very little to be spent on other human welfare activities including technology acquisition (Persely and Lantin, 2000).

In another study on the impact of tissue culture banana biotechnology in Kenya, Qaim (1999) expressed fear that the increase in price of banana plantlets to more than that of conventional ones (plantlets) would result in poor adoption of the technology as most small-holder farmers could not afford it. Poverty, therefore, remains a major determinant of agri-biotechnology adoption by small-holder farmers. A study by Emongor et al. (1999) on viable approaches to biotechnology adoption recommended that resource poor farmers team up in small groups to enhance affordability of biotechnology products such as NCD vaccine. Similarly, Qaim (1999) recommended the establishment of suitable micro-credit schemes to enhance affordability of biotechnology products by the resource
poor farmers who are ultimate target beneficiaries. The two recommendations do underscore the need to enhance the purchasing power of the resource poor farmers for biotechnology adoption. In contrast, agricultural biotechnology adoption initiatives that have acted on the reported recommendations registered positive results. For instance, the International Service for the Acquisition of Agri-biotechnology Applications (ISAAA) Afri Centre’s projects on the transfer of tissue culture banana and tree biotechnologies to small-holder farmers have components of micro-credit schemes to address poverty as a hindrance to biotechnology adoption (Wambugu, 2001; Wakhusama and Kanyi, 2002). Available data indicate that if policies that ensure small-scale resource poor farmers have access to, among others, productive resources including the finances, are put in place, biotechnology adoption would be greatly enhanced (Leisinger, 1999).
CHAPTER 2
LITERATURE REVIEW

2.1 Poultry production in the broader context of food security in Kenya

Available data indicate that the livestock sub-sector, of which poultry production is a part, plays an important role in the livelihood of millions of Kenyans as a contributor to food security (Emongor et al., 1999). Poultry in particular provides meat, eggs and manure for soil enrichment in crop production areas. The sale of poultry and their consumption enhance family incomes and nutrition, respectively. Improvement of poultry production would therefore contribute to enhancement of the living standards of Kenyans especially the rural resource-poor farmers who constitute 80% of the country’s population (Emongor et al., 1999).

Poultry production in Kenya has experienced tremendous growth in the past two decades. Increased demand for eggs and poultry meat in the urban areas has contributed significantly to the expansion of poultry farming. A study by Shompole and Rwambo (1997), established that the majority (90%) of the over 25 million birds in Kenya are local free-range type reared under small-scale operations. In view of the increased demand for poultry meat and eggs as a source of animal protein, poultry production has great potential as it can also be integrated into existing farming practices with ease (Shompole and Rwambo, 1997). According to RoK (1997), enhanced poultry production would contribute significantly to the achievement of the government’s goal of poverty alleviation, food self sufficiency and food security. However, poultry production in Kenya is mainly constrained by NCD outbreaks for which there is need for more studies to establish possible ways of managing the disease (Shompole and Rwambo, 1997).
2.2 The Development of Newcastle Disease Vaccines

One of the key components of modern biotechnology is development of vaccines against livestock diseases (Persely and Doyle, 1999). Most of the losses that occur in livestock in Kenya are due to infectious diseases such as the Contagious Bovine Pleuropneumonia, Rift Valley Fever, Nairobi Sheep Disease, Contagious Caprine Pleuropneumonia, and Newcastle Disease (Shompole and Rwambo, 1997). The rising cost of veterinary drugs coupled with microbial resistance to drugs has necessitated the employment of biotechnology in the development of cost-effective vaccines for the control of epizootic and endemic diseases of farm animals (Shompole and Rwambo, 1997).

Vaccination against NCD has been used successfully since the 1940s. The most successful vaccines against this disease are live attenuated virus vaccines, which consist of lentogenic or selected mesogenic strains produced in eggs (Alexander, 2001). Other types of vaccines that are being developed include the sub-unit and recombinant vaccines (Boursnell et al., 1990; Nagy et al., 1991; Peeters et al., 2001a), and DNA vaccines (Sakaguchi et al., 1996). These live virus vaccines work well when administered correctly but problems arise when insufficient attention in the field is paid to timing, route of inoculation, virus strain and follow-up serology. In particular, it has been found that high levels of passive antibody in young chicks produced from immunized parent flocks can interfere with replication of the vaccine strain (Sakaguchi et al., 1996). Vaccination must therefore be timed such that the level of pre-existing immunity wanes somewhat before young birds are put at risk of exposure to virulent field strains. More often, the challenge virus is able to survive and replicate in the apparently healthy birds and shedding is detected long after vaccination (Parede and Young, 1999). Moreover,
virulent NCD virus strains can be transferred vertically from clinically normal breeds with high levels of antibodies. Questions of whether to vaccinate or not, as well as the need for biosecurity, rather than just vaccination to control NCD virus, have been addressed in detail by Alexander (2001).

Most vaccines against NCD virus are administered through drinking water, aerosols, eye drops or by parenteral routes. Some success has also been achieved through the introduction of the heat-stable feed-pellet vaccine for the small-holder farmers in Africa and Asia (Ideris et al., 1990; Foster et al., 1999; Nasser et al., 2000), and promise to bring about a form of prophylactic control of the disease. The thermo-stable vaccine strain I2 has been developed for the developing countries in Africa and Asia through the sponsorship of Australian Centre for International Agriculture Research (Bensink & Spradbrow, 1999; Nasser et al., 2000). Other opportunities may arise following the completion of sequencing the NCD virus. The introduction of reverse antisense genes to the molecular structure of NCD virus has opened completely new horizons in the development of NCD vaccines. It is now possible to generate recombinant lentogenic Newcastle Disease vaccines from full-length cloned cDNAs (Peeters et al., 2001a; Romer-Oberdorfer et al., 1999). By introducing mutations in either the F or V proteins (Peeters et al., 2001b; Mebatsion et al., 2001) or inserting a foreign gene into the cDNAs (Krishnamurthy et al., 2001), the level of pathogenicity can be markedly reduced to create very safe attenuated live viral vaccines. One of these constructs, Newcastle Disease Virus-P1, was administered in vivo and it was shown to be highly immunogenic as it could induce sufficient immune response to protect chickens with or without
maternally deprived antibodies (Mebatsion et al., 2001). Moreover, such vaccines can be effectively delivered into embryonated eggs in uniform dosage by automation. Probably not unthinkable, but this could very well be the ideal Newcastle Disease Vaccine where embryonated eggs are vaccinated automatically \textit{in vivo} before hatching, thereby significantly reducing both labour and production costs without compromising safety and efficacy levels.

2.3 Efforts to Promote NCDV Adoption by Small-holder Poultry farmers

2.3.1 The case of Kenya

Between 1994 and 1999, the National Animal Husbandry Research Center at KARI, Naivasha under Poultry Research Programme carried out a research project on indigenous chickens. The project had two phases comprising on-station and on-farm trials. The aim of the research was to evaluate growth and production characteristics of indigenous chickens and subsequently to improve their production performance at farm level. It was a process that encompassed the various participatory modes described by Biggs (1989) namely, contractual, consultative, collaborative and collegial. The on-station research was basically of the contractual without any participation of farmers although they were the main clients. From on-station the research process moved into another phase of field survey in the consultative mode of participation. The third phase of research process was the on-farm studies with strong farmer and extension participation. This phase had a collaborative and collegial mode of participation. The main objective of on-station research was to gain experience and an understanding about the characteristics
and nature of indigenous chickens and to generate information on potential performance under improved management.

Several stakeholder workshops were held in 1994. The objective of the workshops was to incorporate divergent views and experiences from a range of stakeholders. The first workshop (Mbogua et al., 1994), aimed at gathering available knowledge on major production systems, production constraints, farmer solutions and researchable constraints. However, there was inadequate representation of primary stakeholders particularly the rural poor subsistence women farmers. Then, networking through field visits was undertaken in 1995 (Ndegwa et al., 1998). The objectives of networking were to establish the status of the poultry industry, share experiences and forge close linkages with several individuals, organizations and institutions (extension, research programmes, universities, development projects, and agri-business). Starky (1996) referred to this kind of networking as ‘Networking’. Research and Extension mini-workshops and meetings were then held. Their objective was to have more focused and detailed discussions about actual field work and to strengthen linkages with frontline extension personnel. Baseline field surveys were done in 1996 in five agro-ecological regions (Naivasha, Njoro, Bahati, Ol Kalou and Ngearua) (Ndegwa et al., 1999). Sixty farmers were covered per region divided into four farmer-clusters. A semi-structured checklist was used to interview farmers as happens during Participatory Rural Appraisal (PRA). The information generated about households and poultry production was recorded.

On-farm farmer participatory research study was carried out between 1996 and 1999. The objective was to evaluate the effects of improved management practices on performance of indigenous chickens at farm level with a focus on farmer participation (J. M. Ndegwa:}
personal communication). The research process involved selection of five regions each of four farmer-clusters and farmers on the basis of willingness. Then training meetings were held for selected farmers plus many others and frontline extension personnel. The farmers were trained on intervention options and implementation while frontline extension personnel were trained on research, monitoring and evaluation. Dissemination of information was a continuous process and different modes were employed. These included existing booklets and manuals, preparation of new materials from information gathered (pamphlets, manual, journal papers), conferences, seminars and workshops.

Sutherland (1998) gave a description of transformation in research processes from conventional research in the 1960s based in research stations that was mainly supply-driven and often unrepresentative of farmers' conditions to Farming Systems Research (FSR) approach developed in the late 1970s. The FSR placed importance on the demand identification via the diagnosis of farming systems, rationalization of research resources through priority setting, testing new technologies under farmers' conditions and developing strong linkages with extension. From mid 1980s, the FSR approach was criticized as being too linear and prescriptive and the generic approach of Farmer Participatory Research (FPR) was developed. The FPR (Okali et al., 1994) placed particular emphasis on farmer participation and incorporated ideas from related approaches such as Participatory Technology Development (PTD), participatory rural appraisal (PRA) and Low External Input Agriculture (LEIA). Farrington (1997) however, suggests that an FSR-type approach may work well for resource-endowed farmers in higher potential areas while FPR would be more appropriate for resource poorer farmers in more marginal areas.
In 1997, KARI, through the support of the Netherlands Government, embarked on a vaccine R&D project focusing on the following diseases: Contagious Caprine Pleuropneumonia, Contagious Bovine Pleuropneumonia, Nairobi Sheep Virus, Rift Valley Fever and Newcastle Disease. The target beneficiary areas for this pilot project were Kakamega and Machakos Districts (Shompole and Rwambo, 1997). The project formulators chose these two districts because they consist mainly of resource poor farmers who practise mixed farming (RoK, 1998). Ordinarily, these areas experience lower livestock productivity than half of their potential production because of various constraints that had not been addressed (RoK, 1997). The vaccines targeting the diseases above were developed and subjected to field trials in the target areas.

A team of KARI scientists and the Ministry of Agriculture of Kenya officials carried out a pilot NCD vaccine extension to farmers in Machakos and Kakamega Districts. The exercise involved a Participatory Rural Appraisal (PRA) during which more than 150 farmers were trained on the use and handling of the vaccine with the hope that they would adopt the technology. In Machakos District, the exercise in which more than one hundred and fifty small-holder farmers participated was conducted in Kaewa Location of Kathiani Division and Matungulu Location in Matungulu Division. In Kakamega District, the PRA, conducted in Lugari, Mumias and Sabatia Divisions, attracted the same number of farmer participants as in Machakos District. The farmers in all the divisions where the exercise was conducted appreciated the importance of Newcastle Disease Vaccine in the fight against Newcastle Disease (Emongor et al., 1999).
In 1998, a field study on the status of village chickens was carried out in Nyando District to document flock characteristics, management methods and identified constraints and opportunities in rearing village chickens in the area. The study established that the village chickens were reared under scavenging systems mainly as a source of income and food. Flock population was 24.2 chickens with 50% chicks and hen to cock ratio of 2.6:1. The productive hens lay an average of 15.4% eggs having 3.1 clutches per year and hatchability of 87.5%. Women own, manage, sell and receive money from chickens' sales in most households. Constraints to rearing chickens were disease predators, poor housing, poor management, lack of feed and low markets and poor markets. It was concluded that potential for village chickens as a source of wealth and development promotion of gender equity and poverty alleviation is enormous and could be harnessed by training farmers and improving management and marketing systems (Kitalyi, 1998).

2.3.2 Diffusion of NCDV biotechnology to farmers in Mozambique

Between 1996 and 2001, the Mozambican National Veterinary Research Institute (INIVE) and the Australian Centre for International Agricultural Research (ACIAR), in collaboration with the National Directorate for Livestock and the National Directorate for Rural Extension, implemented a research project in Mozambique on the control of Newcastle disease in village chickens. The basic objective of Newcastle disease control in village chickens was to improve food security and assist with poverty alleviation of rural and peri-urban households. The project involved; laboratory testing of thermostable, live NCD vaccines (NDV4-HR and I-2); field-testing of these vaccines; the development of appropriate extension material; and attention to cost-recovery and cost minimization issues. The use of thermostable NCD vaccine was essential due to the difficult conditions
in rural Mozambique where the cold chain was often absent or unreliable. The NDV4-HR and 1-2 NCD vaccines performed well under these adverse conditions (Alders et al., 1999). The NDV4-HR vaccine is a commercial vaccine and requires foreign exchange for its importation. As foreign exchange was not readily available in Mozambique, ACIAR provided the 1-2 NCD vaccine master seed free of charge to INIVE to enable the local production of a NCD vaccine suitable for use in village chickens. However, it became apparent that to make NCD control activities sustainable, attention had to be given to social and economic aspects of the work. Linkages with communities were facilitated by collaboration with NGOs such as VETAID, World Vision and Heifer Project International.

The implementation of an effective NCD control program in Mozambique resulted in increased chicken numbers, increased household purchasing power, increased home consumption of chickens' products and increased decision-making power for women (Bagnol, 2001). Despite the need to control NCD in village chickens, it has been difficult to achieve a sustainable control program. Research has shown that a sustainable NCD control program should comprise four (4) essential components: an appropriate vaccine and vaccine technology; effective extension materials and methodologies that target NGO, veterinary and extension staff as well as community vaccinators and farmers; simple evaluation and monitoring systems of both technical and socio-economic indicators; and economic sustainability based on the commercialization of the vaccine and vaccination services and the marketing of surplus chickens and eggs (Bagnol, 2001).

A range of extension material was produced by the project to facilitate access to key information for all those involved with NCD control activities (from National Directors
to farmers). The material included a field manual (Alders and Spradbrow, 2001), a training manual (Alders et al., 2002), a laboratory manual (Young et al., 2002), a flip chart, a vaccination calendar, a vaccination poster, a vaccination song, radio programs, a play, basic vaccine usage instruction sheets, information for vaccine distributors, a pamphlet and a video.

2.4 RATIONALE OF STUDY

2.4.1 Statement of problem

In 1999, the Animal Health Biotechnology Research Programme in Kenya funded by the Government of the Netherlands initiated a project to develop and evaluate rapid diagnostic tests and effective vaccines against livestock diseases. It was anticipated that improvement of animal health would contribute to increase in livestock production and productivity, which would in turn enhance family incomes and also improve human health through increased access to animal proteins. Improved cash earnings could in turn be used to, among others, enhance access to healthcare services. Major Livestock diseases were targeted including the NCD. The project further embarked on dissemination activities such as participatory training of farmers and creation of awareness on the use of vaccines, group formation for vaccine adoption, and also recommended that these activities be maintained by the local Livestock Extension Officers. The project did also recommend that impact assessment of technologies that were in place such as NCD vaccines or those that would be modified quickly be carried out. In view of these recommendations, this study investigated factors influencing adoption of NCD vaccine biotechnology by small-holder farmers in Kathiani and Central
Divisions of Machakos District as these factors in turn directly influence poultry production which is a major contributor to household food security in these two areas.

2.4.2 Research questions

(i) What is the level of awareness of NCD vaccine by the small-holder poultry farmers in the study areas?

(ii) What is the level of affordability of NCD vaccine by the small-holder poultry farmers in the study areas?

(iii) What are the distribution arrangements for NCD vaccine in the study areas?

2.4.3 Justification

A baseline study on the status of the constraints to and opportunities for poultry production as well as the feasibility of adopting animal health biotechnology products in Kakamega and Machakos Districts established that poultry was very popular among the communities in these areas (Emongor et al., 1999). For instance, poultry was ranked second to cattle and the birds are kept mainly for eggs, meat, manure and cash. The study further established that residents rarely sell their poultry and instead prefer slaughtering for home consumption. The consumption of chickens and eggs enhances access to animal proteins by the household family members in the study areas. Poultry production therefore contributes significantly to household food security in these areas and hence would be a good entry point for improvement on the farm because they (poultry) are easily acceptable to the people and are found in most households. Diseases were also found to be a major constraint to livestock production in these areas and because of poverty; most farmers were not able to purchase the required inputs or even the technologies that exist. Farmers had limited information on the existence of these
technologies. Against this background, there is need to assess the level of the NCD vaccine biotechnology adoption by the said small-holder poultry farmers in one or both of the areas after the introduction of NCD in vaccine in 1999 by KARI Biotechnology Centre. Knowledge on factors influencing adoption of NCD vaccine in the pilot project areas of Kathiani and Central divisions would enhance the understanding of ways of improving the adoption of this technology by small-holder poultry farmers elsewhere in Kenya.

The information generated in this study therefore, will be used to improve biotechnology adoption by small-holder farmers countrywide and hence, contribute to alleviating Kenya’s food insecurity. Although the feasibility study of KARI’s Animal Health Biotechnology Project, which encompassed awareness creation on, among others, NCD, was conducted in Kathiani Division, it was expected that then Ministry of Agriculture and Livestock Development through the Livestock Extension Officers would spearhead the NCD vaccine biotechnology diffusion to poultry farmers in the adjacent areas including Central Division. This explains the inclusion of Central Division in this study.

2.5 Hypothesis

2.5.1 Null hypotheses:

(i) Small-holder poultry farmers are aware of the availability of Newcastle Disease Vaccine biotechnology in the study areas

(ii) Small-holder poultry farmers can afford Newcastle Disease Vaccine each time they want to vaccinate their birds in the study areas.

(iii) There are distribution arrangements for NCD vaccine in the study areas.
2.6.0 OBJECTIVES

2.6.1 General Objective

To generate information on factors influencing the adoption of Newcastle Disease Vaccine by small-holder farmers in Kathiani and Central Divisions of Machakos District.

2.6.2 Specific Objectives

(i) To establish the level of awareness on the availability of NCD vaccine by small-holder poultry farmers in the study areas.

(ii) To determine affordability of NCD vaccine by small-holder poultry farmers in the study areas.

(iii) To determine availability of distribution strategies of NCD vaccine in the study areas.
CHAPTER 3
MATERIALS AND METHODS

3.1 Study Site

Kathiani and Central Divisions are located in Machakos District of Eastern Province. From North to South, Machakos District stretches from latitude 0° 45'S to latitude 1° 31'S. From East to West the district is located between longitudes 36° 45'E and 37° 45' West. Kathiani, land area of 178.2 Km sq and Central Divisions, land area of 491.5, Km sq are divided into four (4) and nine (9) locations respectively. The locations in Kathiani Division include Kathiani, Iveti, Kaewa, and Mitaboni. The locations are further subdivided into 21 sub-locations. Central Division, on the other hand, consists of the following locations: Mumbuni, Kiima Kimwe, Masaku, Muputi, Komutwa, Mua Hills, Mutitu, Kathekani and Ngelani. The locations are further subdivided into 31 sub-locations (Appendix 4).

Kathiani and Central Divisions are hilly areas and receive moderately high rainfall. The average annual rainfall and temperatures of 740mm and 22 °C respectively contribute to the two divisions' high agriculture potential. Consequently, agriculture and livestock development are the major forms of livelihood in the two divisions. Among the crops grown in the areas are bananas, coffee, maize, beans, cowpeas, and pigeon peas. The common livestock in the areas under study are cows, goats, sheep and poultry reared mostly on small-scale (Machakos District Development plan (2002-2008).

Poultry disease control is one of the new projects being implemented in the two divisions. Central Division has 150,000 indigenous Chickens s, 60, 000 exotic ones, and 500 geese. Kathiani has 37,100 indigenous chickens, 1,250 exotic ones, 350 Turkeys and 332 ducks.
The aim of this new poultry project in Machakos District is to reduce flock mortalities and weight loss due to disease with a view to increasing meat and eggs output hence increasing rural income and food security. The target poultry disease in this project is NCD.

3.2 Study Population

Kathiani Division has an average population of 95,096 whereas that of Central Division is 143,274. The population densities for Kathiani Division were 462 per Km\(^2\) in 1999, 486 per Km\(^2\) in 2002 and are estimated at 503 per Km\(^2\) in 2004 (Machakos District Development Plan: 2002-2008). The population density of Central division was 292 per Km\(^2\) in 1999, 307 per Km\(^2\) in 2002 and is estimated at 318 per Km\(^2\) in 2004 (RoK, Population census, 1999). According to Machakos District Development Plan (2002-2008), poverty is prevalent in these areas with 62,240 (65.5%) and 43,640 (30.5%) people being poor in Kathiani and Central Divisions respectively. Generally, the average poverty level in the district is 66.2%. Crop production and livestock development activities are the major forms of livelihood in the two divisions. Over 80% of the population in the two divisions depends on this sector.

3.2.1 Inclusion criteria

(i) Poultry farmers in the study areas who consented to participate in the study.

(ii) Any family member of poultry farmers aged 18 years and above

(iii) Poultry farmers who had lived in the areas for at least one year
3.2.2 Exclusion criteria

(i) Poultry farmers in the study areas who did not consent to participate in the study.

(ii) Any member of the family of poultry farmers aged below 18 years.

(iii) Poultry farmers who had lived in the study areas for less than one year.

3.2.3 Ethical considerations

Permission was sought from Kenyatta University, Machakos District Veterinary Officer and Kenya Agricultural Research Institute (KARI) to carry out the study. Respondents were assured that the information they provided would be treated with utmost confidentiality and would only be used for the interviewer’s academic work.

3.3 Research Design

A cross-sectional survey research design was employed in this study. Both quantitative and qualitative research methodologies were employed. Quantitative methodologies involved the use of structured questionnaires to collect quantifiable data from respondents. Qualitative research methods used were Focus Group Discussion guides and unstructured questionnaires to collect data on the views of respondents on various aspects of NCD vaccine and poultry production in the study areas.
3.4 Sample size Determination.

A sample size of 150 poultry farmers that were interviewed was determined by the formula

\[ n = \frac{Z^2 pqD}{d^2} \]

as used by Fisher et al., 1998

Where;

- \( n \) = sample size desired
- \( q \) = 1 - \( p \)
- \( Z \) = The standard normal deviate (1.96) which corresponds to 95% confidence level.
- \( d \) = degree of accuracy desired (0.05)
- \( D \) = Design effect (2) (Kathiani and Central Divisions)
- \( p \) = proportion in target population estimated to be small-holder poultry farmers (0.95)

The target population was greater than 10,000 (95,096 for Kathiani Division and 143,274 for Central Division)

\[ n = \frac{1.96^2 \times 0.95 \times 0.05 \times 2}{0.05 \times 0.05} = 145.98 \approx 150 \]

Hence, a sample size of 150 small-holder poultry farmers was determined

3.5 Sampling Method

The sampling of the five study sites (locations in two divisions) was purposive. The Biotechnology Center of the Kenya Agricultural Research Institute (KARI) carried out a feasibility study on animal health project in these areas in 1999 and, hence, as sponsors of this study they were interested in data from these areas for the programming of their future biotechnology projects. The selected locations were; Kaewa, Iveti and Kathiani of
Kathiani Division and, Mumbuni and Masaku of Central Division. Each location was taken as a cluster. Then, systematic sampling was done using the 1999 census numbering of households to identify the number of households to be studied. Since there were five clusters (each location was a cluster) and the determined sample size was 150 respondents, each cluster had 150/5, giving 30 households from which 30 respondents were selected. From each of the sampled household in a cluster, one respondent was selected for the interview, making a total of 30 respondents per cluster. There are 3,860, 4,555, 4,836, 9,015, and 4,579 households in Kaewa, Iveti, Kathiani, Mumbuni and Masaku locations respectively. The first household selected in every cluster was obtained by dividing the number of households of the cluster by 30 then selecting randomly a number between one and the quotient; the second to be selected was the sum of the quotient and the divisor. The third to be selected was the sum of the second one and the divisor. This order was followed until the required 30 households were selected in each of the five clusters. One respondent from each of the selected households was then identified for interview following the study’s exclusion and inclusion criteria.

3.6 Research Instruments
Pre-tested structured questionnaire and Focus Group Discussion guide were used to collect data from poultry farmers. Data from Divisional Veterinary Officers were collected using a pre-tested unstructured questionnaire.

3.7 Data collection
Respondents were interviewed during visits using a pre-tested structured questionnaire. Kathiani and Central Divisional Veterinary Officers were also interviewed using
unstructured questionnaire. In both cases, the interviewer completed the questionnaire for the respondents. Three Focus Group Discussion (FGD) sessions of an average of six poultry farmers were also conducted to establish the views of poultry farmers on the adoption of NCDV and its effectiveness in controlling the Newcastle Disease. The collected data were then analyzed to determine the answers to the research questions which guided the study.

3.8 Data Management

Quantitative data collected were analyzed using Epi Info software using bar charts and pie charts. Inferential data analysis was done by regression analysis and by using chi-square test to compare the observed and expected frequencies as well as the association between the dependent and independent variables. The dependent variable is the adoption of NCDV whereas the independent variables are the affordability of and awareness on NCDV. The availability of distribution mechanisms for the NCDV is another independent variable whose association with the dependent variable was not determined using the chi-square tool because data collected on it was qualitative. Focus Group Discussion data were analyzed through summary of responses under various themes. The summary themes were then infused into the quantitative data for the presentation of the results and discussion.
CHAPTER 4
RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

A total of 150 respondents took part in the study. The demographic characteristics of respondents investigated included family size and gender, religion, level of education attained, and their alternative income-generating activities.

4.1.1.1 Family Size and Gender

Households in the study areas had relatively large family sizes. Out of the total 150 respondents, 53 (35.3%) hailed from families of greater than six members while only 9 (6%) came from families of between 1 and 2 members (Figure 1). In the context of this study, a family consisted of live parent(s), brothers and sisters. Of all the respondents, 99 (65.3%) were males while 51 (34.7%) were females. Out of the 27 respondents interviewed who were aware of the availability of NCD vaccine, 19 were males while 8 were females. The difference of frequencies observed in family sizes was significant with respondents from family size of 1-2 members being the smallest ($\chi^2_{df\,3} = 33.7367; P<0.05$)
4.1.1.2 Religion

The study areas were predominantly inhabited by Christians belonging to the Catholic faith (41; 27.3%) and several Protestant denominations (108; 72%). About 1% (1) of the inhabitants were Muslims (Figure 2). The difference in observed frequencies of these faiths was statistically significant with Muslims being the fewest ($\chi^2_{df = 2} = 116.920$; $P<0.001$).
4.1.1.3 Levels of Education attained by the respondents

The majority (97; 64.7%) of the respondents had completed primary education while those who had attained secondary education were 49 (32.7%). Only 3 (2%) were illiterate. Less than 1% of the respondents had acquired post-secondary education (Figure 3). The difference observed in the frequencies of various levels of education attained was significant with respondents who had acquired post secondary education and those who had never been to school being the fewest ($\chi^2_{df3} = 167.201; P<0.001$).
4.1.1.4 Means of Livelihood

Residents of Central and Kathiani Divisions practise mixed farming throughout the year. Most of the respondents (99; 66.0%) carry out crop and livestock farming. Among the crops grown are coffee, (cash crop) and bananas, maize, cowpeas, pigeon peas and beans. They rear rabbits, cattle, goats and poultry among other livestock. Forty seven (31.3%) of the respondents exclusively practise crop farming, while the remaining (<3%) are involved in other forms of livelihood (Figure 4). Majority of the respondents (53.3%) own less than 5 acres of land while less than 1% own between 16 and 20 acres of land on which they live and carry out farming activities. The difference in the observed frequency
of these categories of means of livelihood is statistically significant with respondents involved in crop and livestock farming, bee-keeping and other forms of economic activities being fewer ($\chi^2_{df=4} = 250.533; P<0.001$).

**Figure 4: Forms of livelihood for respondents**
4.1.2 STATUS OF POULTRY FARMING

4.1.2.1 Poultry production

Poultry (chickens) rearing was very popular in the study areas. However, the average number of chickens reared in one year was relatively low. One hundred and twenty (80%) of the respondents indicated that they kept an average of less than ten (10) chickens in a year while only 3 (2%) kept an average of more than 20 chickens at any one time in the year. Similarly, 106 (70.7%) of the respondents kept an average of less than 10 growers at any one time in the year preceding the study period. Only 2 (1.3%) of the respondents kept more than 20 growers during the same period. The same trend was observed in the case of adult birds. One hundred and thirty six (90.6%) of the respondents reared less than an average of ten adult birds while only 4 (2.7%) kept more than 20 birds. The general trend was that the majority of farmers (71%) reared less than an average of 10 birds of various age groups in the same period. Poultry in the study areas were reared for meat, manure and eggs for domestic consumption. Over 97% of the respondents indicated that they primarily reared chickens for meat and eggs (Figure 5).
4.1.2.2 Rearing Systems

Chickens rearing system in the study areas was predominantly free-range with 138 (92%) of the respondents practising this system. Only 6 (4%) practised deep-litter or both deep-litter and free-range. The respondents practising free-range system reared local breed of birds. The free-range birds were however kept under enclosures during planting season to avoid destruction of young crops (Figure 6).
4.1.2.3 Incidence of poultry diseases in the study area

According to the respondents, Kathiani and Central Divisions of Machakos district usually experience poultry disease outbreaks during the dry and wet seasons. The most common poultry disease cited was the NCD. This was confirmed by the Divisional Livestock Extension Officers who reported that other diseases such as fowl typhoid, coccidiosis and chicken pox were very rare in the study areas. Newcastle disease (local name- *Mavui*), usually broke out during the dry season that starts around August and extended to September. It also occurred around March and April. All respondents indicated that unlike other poultry diseases, a single outbreak of NCD could claim as
much as 100% of the flock of birds. This was well captured during FGD sessions when some respondents reported that NCD killed all their birds including the chicks and that whenever there was an outbreak they just had to wait to replenish the whole stock. The Central Divisional Livestock Extension Officer (DLEO) corroborated this point by confirming that NCD kills almost the whole flock in a single outbreak.

4.1.2.4 Poultry Disease Management

Poultry farmers in general, used various methods to manage poultry diseases. The methods involved one or a combination of the following; commercial drugs after infection, herbal concoctions after infection and the use of vaccines. The majority of respondents (86; 57.3%) used Indigenous Technical Knowledge (ITK). This involved use of herbal concoctions after noticing infection, while 57 (38%) used both herbal concoctions and commercial drugs. Only 3 (2%) of respondents used vaccines to prevent infection of their birds. The difference between those who used vaccines and those who did not use the vaccine and instead used herbs and drugs (147; 98%), was significant ($\chi^2_{df=1} = 138.240; P<0.001$).
The common herbs used in the management of diseases included, Aloe (*Kiiluma*), Pepper, Croton species (*Muthulu*), among others. The common herbs are used by farmers for any infections of poultry and their knowledge is passed down to new generations. The drugs commonly used included; Panadol, Malaraquine, Oxy-tetracycline hydrochloride (*egocin*) and Potassium permanganate (*Ndonga*). The farmers also gave concoctions of milk and paraffin orally to treat chicken infections. During an FGD session, poultry farmers stressed that they preferred “*Kiiluma*” (Aloe) for most poultry infections because it was relatively more effective according to them than other herbal concoctions.
4.1.2.5 Constraints to Poultry Production

Constraints to poultry farming investigated included diseases, water, feed and accessibility of veterinary services by the farmers. These constraints were investigated in the context of how they impacted on the production of chicks, growers and adult birds.

4.1.2.5.1 Diseases

Diseases were rated as the most important constraints in chicks, growers and adult birds with the majority of the respondents (70.5%) acknowledging this fact (Figure 8).

Figure 8: Levels of Disease constraint to Poultry production
The poultry diseases common in the area included Newcastle disease, fowl typhoid and coccidiosis. Of all these diseases, Newcastle is the most lethal one causing 100% mortality of flock during an outbreak. This was indicated by all the 150 (100%) respondents interviewed.

4.1.2.5.2 Feed

Feed is not a very serious constraint to poultry farming in the study area particularly among resource poor farmers who practice free-range system. This was observed in chicks, growers and adult birds. In all the 3 age groups of reared birds, 72 (46.2%) respondents indicated that feed was the least important constraint to poultry production. Similarly, among the two commercial poultry farmers practising deep-litter system interviewed, feed was still indicated as least important constraint as they could afford it any time they wanted it (Figure 9).
4.1.2.5.3 Access to Veterinary Services

Access to veterinary services was very important for the poultry farmers. This was confirmed by the rating given by the majority of respondents (93; 62 %). It was stated that lack of such services was one of the “most important” constraints to poultry farming (Figure 10).
4.1.2.5.4 Availability of Water

Availability of water to all the age groups of birds was rated as not important at all by the majority of respondents (147; 97.8%) (Figure 11).
4.1.3 LEVEL OF AWARENESS OF NEWCASTLE DISEASE VACCINE

4.1.3.1 Awareness and Use of Newcastle Disease Vaccine

Generally, the use of vaccines in the management of poultry (chickens) diseases was very low as only 3 (2%) of the respondents indicated that they used them (vaccines). Some of the vaccines used by the farmers included Gumboro vaccine and Newcastle Disease Vaccine. NCD vaccine was one of the vaccines used by the respondents who used vaccines 3 (2%) to treat poultry diseases (Figure 12).
The use of NCD vaccine was very low in the study area. While only 3 (2%) of the respondents used NCD, 27 (18%) of the respondents were aware of the availability of the vaccine in the study area. It therefore follows that 24 (16%) who were aware of the vaccine had not adopted it (were not using it). The difference between those who had adopted and those who had not was significant ($\chi^2_{df1} = 138.240; P<0.001$). Similarly, the difference between respondents who were aware of the availability of the NCD vaccine and those who were not aware was significant ($\chi^2_{df1} = 61.440; P<0.001$) (Figures 12 and 13).
Figure 13: Levels of Awareness of Newcastle Disease Vaccine by respondents

4.1.3.2 Reasons for Preference for Herbs in Poultry Disease Control

Out of 150 respondents, 71 (47.3%) preferred the use of herbs because they were readily available and effective while 64 (42.7%) preferred herbs because they were cheap, readily available and effective. Only 7 (4.7%) used herbs because they exclusively thought they (herbs) were effective in treating poultry diseases (Figure 14).
4.1.4 AFFORDABILITY OF NEWCASTLE DISEASE VACCINE

4.1.4.1 Affordability of Newcastle Disease Vaccine (NCDV) by its users.

The affordability of the vaccine (NCDV) by its users was as low as its use (2%). Only 3 (2%) of the respondent indicated they could afford the vaccine every time they intended to vaccinate their birds. Two of them came from Kaewa and Kathiani Locations of Kathiani Division while one came from Mumbuni Location of Central Division. The respondents who indicated they could afford the vaccines were the same ones using the NCD vaccine on their birds (figures 12 and 15). The other 98% of the respondents were
those who were not using NCD vaccine on their birds. The difference between the two
groups was statistically significant ($\chi^2_{df 1} = 138.24; P<0.001$). NCD vaccine was sold in
pack sizes of 100 doses at two hundred and fifty Kenya Shillings (Kshs. 250.00) in the
agro-veterinary shops in the study areas (at the time of the study; April-August 2003.)

**Figure 15: Affordability of NCD vaccine by respondents**

![Pie chart showing the affordability of NCD vaccine. 2% can afford, 98% do not vaccinate/cannot afford.](chart.png)
4.1.4.2 General Opinion on Pack sizes of NCD Vaccine

The respondents who used the vaccine on their birds (3; 2%) were the only ones who expressed opinion on the pack sizes of NCD Vaccine. Two of these respondents indicated that the pack sizes of NCD vaccine of 100 doses were appropriate for their flock sizes. These were respondents who were practising large-scale commercial poultry farming and had well over 100 birds at any one time of the year, all of which were grade birds. The remaining one indicated that the pack sizes of NCD vaccine were not appropriate for their size of flock of birds. This was a small-scale farmer who reared less than 20 local birds throughout the year preceding the study period (Figure 16).
4.1.5 DISTRIBUTION STRATEGIES OF NEWCASTLE DISEASE VACCINE

4.1.5.1 Selling Points of NCD Vaccine

Newcastle Disease Vaccine was sold at the local agro-veterinary shops in Machakos and Kathiani Towns. In Kathiani Town, the only agro-veterinary shop selling the vaccine stocked it on order. All farmers using the vaccine in the study areas (3; 2%) bought it at these two outlets. Apart from the respondents who bought the vaccine from Machakos town-based outlets, those who bought it from Kathiani indicated that sometimes the vaccine was not available there as it was supplied only upon placing an order.
Respondents from Central Division who use the vaccine bought it from Machakos town while those from Kathiani Division bought it from Kathiani Town agro veterinary shop.

4.1.5.2 **Distance to outlets (Agro-veterinary shops)**

Respondents in Kathiani Division who used the vaccine indicated that they took more than 4 hours for a return journey to Machakos to buy the vaccine when it was not available at Kathiani agro-veterinary shop and incurred an average cost of one hundred and forty Kenya Shillings. Poultry farmers from Central Division spent a shorter time and less money to travel to Machakos for the vaccine than their Kathiani counterparts because Central Division was closer to Machakos Town. They spent an average of forty Kenya Shillings for a return trip that took them an hour on average.
4.2 DISCUSSION

4.2.1 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Family sizes in the study areas were big, varying from three to more than six members each (figure 1). This could be attributed to low crude death rate (9/1000) vis-a-vis higher crude birth-rate (46/1000) and a total fertility rate of 3.5. The reported family sizes compare with the district’s average household size of 4.9 (Machakos District Development Plan 2002-2008).

Most of the respondents had acquired primary (97; 64.7%) and secondary (49; 32.3%) levels of education (figure 3). This concurs with available data from Machakos District Development Plan: (2002-2008) which indicate high enrolment rates estimated at 81% in primary schools and relatively lower at secondary school levels (32%) with low drop-out rates standing at 4.7% and 5.5% in secondary and primary schools respectively. According to the Central Divisional Livestock Extension Officer, the high enrolment at primary levels could be associated with the relatively lower cost of basic education that is affordable by most of the parents in the study areas, while inability to raise fees could be the main reason for relatively lower enrolment in secondary schools. The reported high completion rate of primary level of education is a clear reflection of high literacy levels in the district averaging 75.9% (Machakos District Development Plan, 2002-2008). The respondents who had acquired post secondary level of education were relatively fewer (0.7%) than those who had both the primary and secondary levels (64.7% and 32.3% respectively) (figure 3). This confirms responses from a number of respondents during FGD that some of their family members were in urban areas particularly Nairobi and Machakos engaged in formal employment. These findings in turn, concur with the
available data from Machakos District Development Plan of 2002-2008 indicating that more than half of the whole population of Machakos District (532,137) is in urban areas against the total district population of 954,082.

Most of the respondents practise mixed farming (Figure 4). This kind of farming is favoured by the high potential for agriculture in the areas (Kathiani and Central Divisions) as opposed to other divisions in the district that are relatively drier. For instance, these two divisions receive an average annual rainfall of 740mm which guarantees availability of green pasture and water for livestock most of the year as well as high crop production (RoK, 1999). Available data from Machakos District Development Plan: 2002-2008 indicate that agricultural sector accounts for 70% of the total workforce in these two divisions. The inhabitants of Kathiani and Central Divisions grow maize, beans, pigeon peas, cowpeas, sorghum and cassava and rear cattle, goats, sheep and poultry. On average livestock sub-sector contributes 80% of their gross household income. This supports the findings of a feasibility study on the animal health biotechnology project by Emongor et al. (1999) which established that mixed farming is widely practiced by small-holder farmers in Machakos District.

4.2.2 STATUS OF POULTRY FARMING IN THE STUDY AREA

4.2.2.1 Poultry rearing systems

It is evident that in the study areas, free-range system of poultry rearing is more widely practised by poultry farmers (92%) than the deep-litter system (4%) (Figure 6). The respondents who practised free-range system cited the little care/cost burden it places on them for its preference. The forms of care include provision of water, veterinary services
and shelter. However, according to the respondents who practice free-range system (92%) one of its shortcomings is loss of poultry to predators as well as low quality poultry production.

Available data from other studies indicate that indigenous fowls reared under free-range system are more resistant to tropical poultry diseases than the exotic ones mostly reared under the deep-litter system (Oluyemi et al., 1979). Moreover, the Central Divisional Livestock Extension Officer indicated that the deep-litter system is mostly preferred by large-scale farmers whose purpose of farming is purely commercial. Hence, the need for quality poultry production necessitates good management practices involving provision of shelter, feed, water and veterinary services.

From this study, it is clear that the majority of poultry farmers carry out small-scale poultry farming in the study area. On average, the farmers rear up to 10 birds of each age group (Chicks, Growers and Adults) (Figure 5). This supports findings by Emongor et al., 1999 that small-holder poultry farmers in Machakos District rear an average of ten birds throughout the year. The study further established that rearing poultry on small scale in the area was attributable to poultry disease epidemics including NCD which were common in the area. The high mortality of birds resulting from NCD outbreaks could also have contributed to small-scale poultry production in the study areas. This could be linked to a study by Kaschula (1961); which established that loss of millions of poultry to NCD was a major contributing factor to the small-scale poultry farming in Nigeria. The respondents reported that due to NCD usually breaking out during the dry season (August...
to December), they lose almost all their birds and have to buy more to replenish the stock thereafter.

4.2.2.2 Poultry Disease Incidences and Management

The most common poultry disease outbreaks in the area are those of NCD. According to the Central Divisional Livestock Officer, a single NCD outbreak may result in 100% loss of birds. This concurs with findings of earlier studies that NCD is the most important and destructive poultry disease in the rural areas as it causes death of millions of birds and economic loss through the slaughter of sick birds which are sold very cheaply (Kaschula, 1961; Abdu et al., 1985b, 2000). A morbidity rate of 80% has been recorded in a natural outbreak (Fatunmbi and Adene, 1979). In most outbreaks, 45-100% of the birds in a flock die of the disease (Abdu and Saiudu, 1990; Alexander, 1989, 1997).

Poultry farmers indicated that they manage this disease through the use of herbal concoctions, vaccines and veterinary drugs. However, exclusive use of herbal concoctions by farmers (86; 57.3%) is the most prevalent mode of treating poultry diseases in the study areas (Figure 7). According to the Central Divisional Livestock Extension Officer, the reported use of herbs by small-holder farmers is, among others, due to low levels of awareness on other important interventions such as NCDV (Figure 13). Studies indicate that limited awareness about the existing biotechnology interventions results in farmers adopting alternative methods (Keya et al., 1981; Emongor et al., 1999). Only 18% of respondents were aware of the availability of NCDV in the study areas. Similarly, the majority of respondents (147; 98%) indicated that unaffordability of the vaccine has contributed to the prevalent use of herbs. Out of the
18% (27) of the respondents who were aware, only 3 (2%) were using the vaccine because they reported that they could afford (Figure 15). A study by Qaim (1999), recommended that micro-credit facilities be started to enhance the affordability of agricultural biotechnology products. The prevalence of high poverty levels of 66% in the study area (Machakos District Development Plan; 2002-2008) could also contribute to low affordability of the vaccine by the small-holder poultry farmers. Farmers who used the vaccine (3%) cited its effectiveness as the reason for their preference. This supports earlier findings by Mohammed et al. (1998) that vaccination against NCD reduces poultry losses. The respondents who exclusively used herbal concoctions (86; 57.3%) gave various reasons for their choice. Among the reasons cited, were that the concoctions were cheap and readily available, as well as lack of formal knowledge on poultry management (Figure 14). However, the respondents who used the herbs to treat NCD indicated that their birds still died even after administration of the herbal concoctions. In a study on the effectiveness of NCDV against the lentogenic form of NCD in ostriches by Beard, (1979), all the experimental birds survived while the controls died. These findings, too, confirm that NCD is most effectively controlled by the NCD vaccine.

4.2.2.3 Constraints to Poultry Production

From the foregoing, it emerged that poultry diseases and access to veterinary services were the two most important constraints, among others (Figures 8 and 10). All the respondents interviewed (150; 100%) admitted that NCD was the single biggest killer of poultry; claiming 100% of the birds in a single outbreak (Figure 12). This supports similar earlier findings by Alexander (1987, 1997) that NCD outbreaks cause 100% mortality in poultry. The Central Divisional Livestock Extension Officer reported that
poor access to veterinary services due to the breakdown of extension services has resulted in heavy losses of birds to NCD; thus seriously affecting poultry production in the study areas. The respondents observed that if extension officers were actively involved, they (respondents) would easily have access to veterinary services and their birds would not die in such large numbers. This explains why many of them (93; 62%) rated access to veterinary services as most important. Some respondents did associate veterinary services to cows, goats and sheep only but the realization that such services covered poultry as well, made them eager to have those services for their birds. The importance of veterinary extension services in enhancing access to biotechnology products has been emphasized in the Kenya National Council of Science and Technology’s Technology Policy report of 1980. The report recommended that extension services be used to facilitate the diffusion of agricultural technologies among the farming communities in Kenya.

Availability of water and feed for the three age groups of birds on the other hand was rated as not important at all by the majority of respondents (98%) (Figures 9 and 11). According to the Central Divisional Livestock Extension Officer (DLEO), this rating was attributable to the fact that Kathiani and Central Divisions receive relatively higher rainfall (740mm) than other divisions in the district resulting in higher agricultural production. This in turn, guarantees the availability of food and feed for the people and birds respectively. Similarly, available data indicate that the areas have efficient water supply systems (Machakos District Development Plan; 2002-2008). Hence, availability of water to most households was also guaranteed. The respondents in the study areas who practise free -range farming system (138; 92%) indicated that the birds have to fend for themselves in the field. Therefore, provision of feed and water are not issues of concern...
to the small-holder poultry farmers in the study areas. However, according to the large-scale commercial poultry farmers interviewed, water and feed are very important inputs as birds are confined to enclosures (Figure 6).

4.2.3 LEVEL OF AWARENESS OF NEWCASTLE DISEASE VACCINE

Biotechnology continues to receive wide recognition for its capacity to, among others, enhance food security particularly among the small-holder farmers in Africa. Unfortunately, there is inadequate awareness creation on biotechnology at the grass-root level (Keya et al., 1981). The reported poor NCDV biotechnology adoption levels (3%) (Figure 12) in the study areas could therefore be partly linked to the poor awareness creation efforts as reported by Keya et al., 1981; Emongor et al., 1999; Qaim, 1999. The response by most respondents that they had not adopted NCDV biotechnology because nobody had ever told them about it corroborates the said findings that poor awareness creation of existing biotechnology products leads to low adoption of those products. As a result, the poultry farmers resorted to the use of herbs and veterinary drugs in controlling poultry disease outbreak (Figure 7). This further supports the findings by Emongor et al., 1999 that due to low awareness on NCDV most poultry farmers resort to the use of Indigenous Technical Knowledge (ITK) to control poultry diseases in Machakos and Kakamega Districts. The use of ITK resulted in limited effectiveness in controlling poultry loss as the respondents (86; 57.3%) confessed that as high as 100% poultry losses occurred despite the use of the reported interventions. The 147 (98%) poultry farmers interviewed who were not using the vaccine expressed utmost need to adopt the NCDV to stem unnecessary heavy losses of their birds. However, they requested that awareness creation campaign on NCDV be stepped up to facilitate the technology adoption. The role
of improved information flow has in fact been stressed and recommended as a requisite condition for biotechnology adoption (Qaim, 1999). In the 1950s and 1960s vaccination campaigns for the prevention of NCD in village poultry were organized by the regional governments in Nigeria with a view to increasing people's awareness about NCD (Abdu et al., 2000). Lack of awareness creation about other existing forms of biotechnology has also hampered their adoption. These include rhizobium inoculant's biotechnology (Keya et al., 1981; Woomer, 1991). In Kakamega and Kisii where the inoculants were introduced, only 2% of the farmers adopted the technology due to poor awareness (Keya et al., 1981).

The small-holder farmers did, in fact, suggest that KARI intensifies holding awareness raising seminars on Newcastle Disease Vaccine so that many people could know about it. The free flow of information would also help the farmers understand basic diagnosis of common poultry diseases and available drugs and/or vaccines for them. Linkages with organizations such as African Biotechnology Stakeholders Forum (ABSF) whose main role is awareness creation on biotechnology would come in handy. In fact, most of the unpublished survey reports by ABSF indicate that the minimal biotechnology adoption and/or appreciation in Kenya are a result of poor awareness and/or understanding of biotechnology. Generally, it seems there is a weakness in enforcing the NCST's 1980 Technology Policy report that awareness creation on new technologies should be promoted to enhance their adoption and increase food security for Kenyans. However, currently, a number of biotechnology initiatives in Kenya are making efforts to incorporate a component of marketing to ease accessibility by small-holder farmers. For instance, Tree Biotechnology Project of the Forest Department of Kenya carries out its
awareness raising activities through exhibition and events held at the trial and demonstration sites, participation in agricultural shows, the provision of information booklets, and the taking of editorial and advertising space in newspapers and radio. Commercial forestry companies are also being approached directly, while communication aimed at small-scale farmers is directed largely through NGOs (Wakhusama and Kanyi, 2002).

4.2.3.1 Veterinary Extension Services

The breakdown of extension services has partly contributed to poor awareness creation on the availability of essential services for the farmers particularly in rural settings (Emongor et al., 1999). Farmers who participated in the study indicated that they did not know what new agricultural products there were until they went to the local agro-veterinary outlets. The attendants at the agro-veterinary shops furnished them with "relevant" information. The danger in this approach to information access is that it is provided with a profit-making consideration. As a result, some farmers have had to buy products that are not useful to their needs. For instance, the widespread use of "Ndonga" (Potassium Permanganate) to control NCD is attributed to the advice from the local agro-vet attendants. Despite the widespread use of "Ndonga", farmers admit they have continued to lose their birds during NCD outbreaks. Owing to the breakdown of extension services, farmers have to rely on local provincial administration officers for information. The area Chiefs and Assistant Chiefs play the important role of informing the farmers about new development strategies in the agricultural sector. While this could come in handy, under the circumstances, it has a potential shortcoming of misinformation as these administrators lack professional capacity to disseminate information on
veterinary issues. Kenya’s technology policy report (NCST’s 1980 Technology Policy Report) did also recommend that extension services be promoted to enhance technology adoption by the target beneficiaries. The enforcement of this report too, has been weak.

4.2.4 AFFORDABILITY OF THE NCD VACCINE

The poor Newcastle Disease Vaccine biotechnology adoption in the study areas is, to a great extent, due to the prevailing poverty situation (average poverty levels in the District are of 66.2% according to Machakos District Development plan: 2002-2008). Due to this, small-holder farmers’ priorities shift towards meeting their very basic needs of which purchase of NCD vaccine is not (Persley and Lantin, 2000). As reported by Qaim (1999), socio-economic status plays an important role in determining biotechnology adoption by small-holder farmers. The respondents who knew but did not use the vaccine (24; 16%) argued that they could not afford it. They therefore preferred to use herbs, which were relatively cheaper, although ineffective in controlling poultry diseases, particularly Newcastle Disease (Figure 7). If the farmers opted for NCDV instead of Indigenous Technical Knowledge (ITK) they would have to pay for the transport facilitation of the veterinary officer to their homes as well as meet the cost of the vaccine. With the current liberalization of veterinary services, most small-holder farmers cannot afford these costs, so they resort to ITK. Yet, divisional (Kathiani and Central) project evaluation results indicate that livestock-based income-generating projects are relatively more viable than the agricultural ones. This means that there has been no mechanism in place to actualize the recommendations (Emongor et al., 1999) of small-holder farmers teaming up to enhance affordability of the vaccine. Similarly, establishment of suitable micro-credit schemes to enhance biotechnology affordability by the small-holder farmers as
recommended (Qaim, 1999) has not been effected in the study areas. Unless these recommendations or similar ones that enhance the purchasing power of small-holder farmers are implemented, biotechnology adoption may remain an everlasting challenge.

4.2.5 DISTRIBUTION NETWORK FOR NEWCASTLE DISEASE VACCINE

Efficient distribution network is necessary for enhanced accessibility of the biotechnology products at the rural grass-root level (Qaim, 1999). According to Central DLEO, the distribution arrangement for the NCDV in the study areas is very poor as the vaccine is only delivered to the farmers from the Central store in Machakos town upon their request. A study by Emongor et al. (1999) recommended that, farmers form groups that would pull resources and get the benefits of training from the local veterinary officers when need arises. However, according to the DLEO, this is reportedly not working so well due to lack of commitment and high poverty levels prevalent in the study areas. The poultry farmers in the study areas expressed need to be involved in the distribution of NCD vaccine through their farmers’ groups because they strongly believe this would be relatively cheaper. However, the DLEO reported that the framers’ needs cannot be realized due to lack of requisite storage facilities for the NCD vaccine in remote areas of the study divisions. Moreover, the DLEO revealed that currently, the Ministry of Livestock and Fisheries Development in the district is extremely understaffed rendering the undertaking of some key functions difficult. For instance, the DLEO revealed that there was no Livestock Field Extension Officer in the whole of Central Division of Machakos District at the time of the study. The recommendation by Emongor et al. (1999) that farmers’ groups, co-operatives or local Community-Based Organizations and Non-Government Organizations be involved in the marketing and
distribution of existing agri-biotechnologies including Newcastle Disease Vaccine seems not to have been implemented. The recommendation further emphasizes that under the arrangement of using CBOs and NGOs, the said requisite vaccine storage facilities would be accessed, making it easy to distribute the vaccine. The important role of Non-Governmental Organizations in the distribution of key technological products among small-holder farmers in rural areas has also been stressed in a report by FAO’s Inter-Agency Task Force on the UN response to long term food insecurity in the Horn of Africa (FAO, 2000). A similar study established that lack of availability of the rhizobia inoculant close to the farmers was a major reason for the biotechnology’s low adoption levels (MIRCEN-UNEP, 1995).
CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Following the investigation of the factors influencing the adoption of NCD vaccine biotechnology in the two project areas, the following conclusions were drawn.

1. There is very low Newcastle vaccine biotechnology adoption by small-holder poultry farmers in the study areas due to low awareness levels, poor affordability and lack of vaccine distribution strategies.

2. Most small-holder poultry farmers in the study areas lose many of their birds during NCD outbreaks due to low adoption of NCDV and use herbal concoctions to treat poultry diseases including Newcastle disease.

3. Most small-holder poultry farmers in the study area practise free-range rearing system because it places little care burden on them while commercial poultry farmers practise deep-litter rearing system to enhance care resulting in enhanced production and hence, profit maximization.

4. Small-holder poultry farmers are not readily willing to spend money on poultry disease management because they do not regard that as a priority issue against the background of scarce financial resources.
5. Small-holder farmers do associate veterinary services with cattle, goats and sheep only but not poultry. They think veterinary services do not target poultry, so they do not seek veterinary services when their birds are sick.

6. NCD Biotechnology may not contribute significantly to household poultry production in the study areas if poverty (that leads to unaffordability), awareness creation and distribution arrangements are not addressed comprehensively.

5.2 RECOMMENDATIONS

To improve the adoption of NCD vaccine biotechnology in the two project areas with a view to enhancing household poultry production, this study made the following recommendations.

1. Poverty (that leads to unaffordability) is partly responsible for the poor adoption of NCD vaccine. The Government of Kenya and relevant Non-Governmental Organizations should organize programmes on economic empowerment for small-holder poultry farmers to enhance affordability of the NCD vaccine. Similarly, small-holder poultry farmers should sell some of their birds to raise money to meet the vaccination expenses for the rest of the birds.
2. Veterinary extension service system should be strengthened by the Government of Kenya and other agricultural sector stakeholders to enhance access to those services and information by small-holder farmers at the grassroots.

3. Awareness creation/raising and distribution systems of the NCDV should be improved by agricultural biotechnology stakeholders to reach grass-root poultry farmers who are reportedly under-served. Local provincial administrators and CBOs such as women groups, youth groups and Faith Based Organizations should be empowered by the local Divisional Livestock Extension Office to create awareness on the availability of NCD vaccine including informing small-holder poultry farmers about the alternative sources of affordable vaccines such as KEVEVAPI.

4. Alongside NCDV, penside diagnostic kits should be introduced by the vaccine producers to enable farmers diagnose poultry diseases correctly.

5. Newcastle Disease Vaccine (NCDV) manufacturers should develop small pack sizes of the vaccine to suit smaller flock sizes of most poultry farmers in the study areas. Alternatively, small-holder farmers should form small groups that will be suited by the current 100-dose pack size of NCDV.
6. Vaccine distributors in the project areas should stock thermostable NCD vaccines that are suitable for rural areas where the cold chain is absent or unreliable.

7. Future work should investigate the views of farmers on the adoption of biotechnology products resulting from genetic engineering.
REFERENCES


Food and Agriculture Organization (FAO, 2000), Administrative Committee on Coordination Report.


Machakos District Development Plan Unit (2002-2008)


Generation of a recombinant chimeric Newcastle disease virus vaccine that allows serological differentiation between vaccinated and infected animals. *Vaccine.* 19: 1616 –1627.


Spillane, C. (1999). Commission on Genetic Resources for Food and Agriculture. Recent developments in Biotechnology as they relate to plant genetic resources for food and agriculture. *FAO. Background study paper* No. 9


APPENDIX 1

QUESTIONNAIRE FOR POULTRY (CHICKEN) FARMERS

Poultry is a great contributor to household food security in Machakos District yet, its production is seriously affected by Newcastle Disease (NCD). Newcastle disease vaccine was introduced in the district for the poultry farmers to vaccinate their birds. The purpose of this study therefore, was to collect data on NCD vaccine adoption by smallholder poultry farmers in Kathiani and Central Divisions. The data sought would be used by the livestock programme implementers to improve the fight against NCD.

LOCATIONAL IDENTITY:

1. Division

2. Location

3. Sub location

PERSONAL INFORMATION

1. Name of household head

2. Name of respondent

3. Age

4. Relationship between respondent and household head. Respondent is


6. Household head 7. Others specify

5. Gender 1. Male 2. Female

6. Family Size (living members only) :- (Mother, Father and children)

1. (1-2) 2. (3-4) 3. (5-6) 4. (greater than 6) 5. Specify

7. Religion


8. Level of education attained

1. Primary 2. Secondary
3. Post secondary
4. Never went to school at all

9. Date of interview____________________

10. Name of interviewer_________________

11. Questionnaire serial number______________

PROJECT INFORMATION:
A. Status of poultry (chicken) production

1. Do you rear chicken? □
   1. Yes
   2. No

2. Give the number of chicken by age group reared at any one time by you in the last twelve months.

<table>
<thead>
<tr>
<th>Chicken category</th>
<th>No of indigenous birds</th>
<th>No of grade birds</th>
<th>No of cross breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chicks (less than 3 months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Growers (4–6 months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Adult (Over 6 months)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. What is your family land acreage? □
   1. (0-5) Acres
2. (6-10) Acres
3. (11-15) Acres
4. (16-20) Acres
5. (Over 21) Acres
6. (I don’t know)

4. What is the other form of livelihood for your family apart from chicken rearing? □
   1. Crop farming
   2. Livestock (cattle, pigs, goats, sheep, rabbits) farming
   3. Bee keeping
   4. (1 and 2)
   5. (2 and 3)
   6. (1 and 3)
   7. (1, 2 and 3)
   8. None
   9. Others specify __________________________

5. What kind of chicken rearing system do you practice? □
   1. Free Range
   2. Deep litter
   3. Both free range and deep litter

B. Constraints to Poultry Production

6. The constraints to poultry production have been rated on a scale of 1 to 4. For each age group of chicken select the level of constraint as indicated on the scale.

   Scale
   4 = Most important
   3 = Important
   2 = Least important
   1 = Not important at all
<table>
<thead>
<tr>
<th>Chicks’ Constraints</th>
<th>Level of constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Feed</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Access to veterinary services and drugs</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Water</td>
<td>4 3 2 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growers’ constraints</th>
<th>Level of constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Feed</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Access to veterinary services</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Water</td>
<td>4 3 2 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adults’ constraints</th>
<th>Level of constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>4 3 2 1</td>
</tr>
<tr>
<td>Feed</td>
<td>4 3 2 1</td>
</tr>
</tbody>
</table>
7. Which of poultry diseases has the highest frequency of outbreak in your area?
   1. Mavui
   2. Nyongo
   3. Maunza
   4. Others specify

8. What is the frequency of outbreak of the disease selected in Q7 above?
   1. After three months
   2. After six months
   3. After twelve months
   4. Others (Specify)

9. Which one of the following poultry diseases kills the highest number of birds during a single outbreak if not treated?
   1. Mavui
   2. Nyongo
   3. Maunza
   4. Others (specify)

10. What is the frequency of occurrence of the disease with highest deaths during a single outbreak?
    1. After 3 months
2. After 6 months
3. After 9 months
4. After 1 year
5. Others specify__________

11. How many of your chicken die of the disease with the highest death rate during a single outbreak if not treated? □
   1. Less than one quarter of the chickens
   2. More than one half
   3. All of them
   4. Other specify__________________

C. Management of Constraints

12. How do you manage diseases in your chicken? □
   1. Through use of commercial chicken drugs after infection.
   2. Through use of herbs after infection
   3. Through use of vaccines
   4. Both 1 and 2
   5. 2 and 3
   6. 1 and 3
   7. 1, 2, and 3
   8. I do nothing about the diseases
   9. Others specify__________________

13. Why do you use the method selected in Q12 above to manage chicken diseases? □
   1. It is cheap
   2. It is readily available
3. It is the most effective one

4. Both 1 and 2

5. Both 2 and 3

6. Both 1 and 3

7. 1, 2 and 3

8. I have no knowledge on poultry disease management

9. Others specify _______________________

14. Are you aware of the availability of Newcastle Disease Vaccine for "Mavui"? ☐
   1. Yes
   2. No

15. Do you use Newcastle vaccine to vaccinate your birds? ☐
   1. Yes
   2. No

16. Have you received any relevant training on proper handling of this vaccine? ☐
   1. Yes
   2. No

17. How often do you vaccinate your birds with Newcastle Disease Vaccine? ☐
   1. Once a month
   2. Twice a month
   3. Once in six weeks
   4. Not at all
   5. Very irregularly
   6. Others specify ____________
D. Affordability and accessibility of Newcastle Disease Vaccine

18. Can you afford the vaccine each time you intend to carry out vaccination of your birds? □
   1. Yes I can
   2. No I cannot
   3. I do not vaccinate my flock

19. Where do you purchase the Newcastle Disease Vaccine? □
   1. At the Divisional Veterinary Office
   2. At the local Non Governmental Organizations
   3. At the local Farmers' Cooperative Union
   4. At the local agro veterinary outlet
   5. I do not vaccinate my flock so I don't buy the vaccine
   6. Others (specify)__________________________

20. Is the Newcastle Disease Vaccine available at the selling point selected in Q19 above every time you need it? □
   1. Yes
   2. No
   3. I do not use the vaccine

21. How long do you take on foot to reach the selling point selected in Q19 to buy the vaccine? □
   1. Less than 30 minutes
   2. (About 1 hour)
   3. (About 2 hours)
   4. (More than 2 hours)
   5. Not applicable because I don't buy the vaccine
22. Would you like the selling point for the vaccine changed? 

1. Yes  
2. No  
3. Not applicable-I do not buy the vaccine

23. Why would you like the selling point changed? 

1. It is very far  
2. Business time is very short at the selling point  
3. Vaccine is out of stock at the selling point most of the time  
4. Both 1 and 2  
5. Both 2 and 3  
6. Both 1 and 3  
7. All 1, 2, and 3  
8. Not applicable (I do not buy the vaccine)  
9. Others specify __________________________

24. What is your opinion on the suitability of the current packaging system of Newcastle Disease Vaccine for your flock? 

1. Pack sizes ARE appropriate for my flock of chicken  
2. Pack sizes are NOT appropriate for my flock of chicken.  
3. I have no opinion because I do not use the vaccine.  
4. Others specify __________________________

Thank you for your time.
APPENDIX 2

QUESTIONNAIRE FOR VETERINARY OFFICERS

Poultry is a great contributor to household food security in Machakos District yet its production is seriously affected by Newcastle Disease (NCD). Newcastle disease vaccine was introduced in the district for the poultry farmers to vaccinate their birds. The purpose of this study therefore, was to collect data on NCD vaccine adoption by small-holder poultry farmers in Kathiani and Central Divisions. The data sought would be used by livestock programme implementers to improve the fight against NCD.

A. PERSONAL INFORMATION

Name of Veterinary Officer: -

Designation of Veterinary Officer: -

Administrative Division: -

B. PROJECT INFORMATION:

1. What is the current poultry (chicken) population in the Division:-

2. What are the four (4) major poultry diseases in the Division in order of their severity?

1. _______________________________ (Most severe)

2. _______________________________

3. _______________________________

4. _______________________________ (Least severe)
3. Estimate the percentage number of flock of chicken that die from the diseases in Q2 above in a single outbreak if not treated.

1. __________________________ (Most severe)
2. __________________________
3. __________________________
4. __________________________ (Least severe)

4. How are the diseases in Q3 above managed?

1. __________________________ (Most severe)
2. __________________________
3. __________________________
4. __________________________ (Least severe)

5. How frequent does Newcastle Disease occur in the Division?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

6. Describe the level of Newcastle Disease vaccine use by farmers in the Division?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

7. What is the current distribution and awareness raising system of Newcastle Disease Vaccine in the Division?
8. What is the current price of a unit pack size of Newcastle Disease Vaccine commonly purchased by farmers in the Division? Why?

9. What other pack sizes of Newcastle disease vaccine are currently available in the market in the Division?

10. How often should poultry vaccination against Newcastle Disease be carried out?

11. Describe the current method of communication between Divisional Veterinary Office and poultry farmers at the grass root level?

Thank you for your time.
APPENDIX 3

FOCUS GROUP DISCUSSION GUIDE

Poultry is a great contributor to household food security in Machakos district yet, its production is seriously affected by Newcastle disease (NCD). Newcastle disease vaccine was introduced in the district for the poultry farmers to vaccinate their birds. The purpose of this study therefore, was to collect data on NCD vaccine adoption by small-holder poultry farmers in Kathiani and Central Divisions. The data sought would be used by livestock programme implementers to improve the fight against NCD.

1. What do you keep poultry for?

2. How do you control poultry diseases in your community? (Probe for use of indigenous Technical Knowledge (ITK), veterinary drugs and poultry vaccines.)

3. Why do you prefer the methods named in Q2? (Probe for details on each method)

4. How did you learn about these methods of poultry disease control (Probe for availability of veterinary extension services in the area)

5. Explain the effectiveness of each method in controlling poultry disease (Probe for opinion on effectiveness of Newcastle Disease Vaccine (NCDV) if there are users, probe for the number of birds that die after using each of the mentioned methods)

6. Where do you obtain the products used in controlling poultry diseases (Probe for the cost of each product and time taken to where the products are obtained?)

7. Suggest what you would like to be done to improve poultry disease management in your respective locations (Probe for reference to need for veterinary services, need for any kind of subsidy, economic empowerment or awareness creation on existing technologies.)
APPENDIX 4
Study Areas For New Castle Disease Vaccine In Kathiani And Central Divisions Of Machakos District

LOCATION OF MACHAKOS IN KENYA

HIGHLIGHT OF STUDY AREA IN MACHAKOS
ADMINISTRATIVE DIVISION MAP

MAP OF THE STUDY AREAS

LEGEND
- Kathiani / Central division Boundary
- Location Boundary
- Sub-Location Boundary
- Town / Trading Centre
When replying please quote:

Our Ref:    
Your Ref:   

Mr. Mutinda Nzomo  
C/o DALEO  
P. O. Box 555  
MACHAKOS.

Dear Mr. Nzomo,

RE: IMPACT ASSESSMENT OF NEWCASTLE DISEASE VACCINATION IN MACHAKOS.

You will recall the KARI-led Newcastle vaccination studies in Mwaia, Nithi, Yatta and Matungulu divisions of your district. We now would like to assess the impact of this exercise in the four Divisions and develop a way forward for the rest of Kenya.

The bearer, Mr. Gabriel Muswali is the scientist who will undertake the study and would like to request your office to assist him in the necessary logistics, specifically contacts with the relevant divisional and frontline staff to obtain the necessary information.

Sincerely,

Christopher K. Ngichabe, Ph.D.  
Coordinator, KARI Biotechnology program