Asam Said Ahmed Hassan Shahin

Adoption of Innovations in Smallholder Buffalo Dairy Farms in the Menoufia Province in Egypt

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Adoption of Innovations in Smallholder Buffalo Dairy Farms in the Menoufia Province in Egypt

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List of Acronyms

AERDRI	Agricultural extension and rural development research institute
AI	Artificial insemination
ARC	Agricultural research center
AOAD	Arab Organization for Agricultural Development
BST	Bovine somatotropin
BBM	Broad-bed maker (Drainage equipment)
CAMPS	Central agency of Public Mobilization and statistics
DRC	Desert Research Center
EBPA	Egyptian Buffalo Producers' Association
FAO	Food and Agricultural organization
FMD	Foot and mouth disease
GAAMG	General administration of agriculture, Menoufia Governorate
GAAMG	General Authority for Agrarian Reform
GADHDL	General Authority for Developing the High Dam Lake
GDP	Gross domestic product
GOVS	General Organization for Veterinary Services
ISNAR	International service for national agricultural research
Kg	Kilogram
L.E.	Egyptian currency
MALR	Ministry of Agriculture and land Reclamation
MPWWR	Ministry of public works and water resource
NAI	National agricultural income
NAI	National agriculture income
NBE	National Bank of Egypt
NRC	National Research Center
NWRC	National Water Research Center
P	Probability
PBDLAC	The Principal Bank for Development land Agricultural Credit
SE	Standard error
SSR	Self-sufficient ratio
TLU	Tropical livestock unit
%	Percent

1 Introduction

Confronting the food crisis and increasing agricultural production have become major concerns of much of the developing world in the past decades. A number of crucial factors account for increases in agricultural production and productivity, but the contribution of agricultural research in developing economically useful technology and the contribution of agricultural extension in disseminating this technology and making it available to the farmers are unquestionably of great importance (JOHNSON and CLARK, 1983; MOHAMED and MAHMOUD, 1993). The Government of Egypt places paramount importance on the agricultural sector, which account for about 20% of both the GDP and total exports, and about 34% of the employment (NBE, 1998). The agricultural sector contributes to the overall food needs of the country, provides the domestic industry with agricultural raw materials, and promotes industrial development through expanding the market for industrial goods such as pesticides, chemical fertilizers, equipment and machinery. Therefore, agricultural sector helps in financing economic and social development through the net capital outflow from agricultural to the other sectors of the economy (MALR, 2001).

Livestock plays an important role in the agricultural sector; it contributes directly and indirectly to agricultural production. The number of Egyptian buffaloes, cows, sheep, goats, camel and riding animal in Egypt is about 3.33, 3.42, 4.40, 3.30, 0.20 and 1.40 million head in 1999, respectively. The number of animals in Menoufia province is about 272, 161, 145, 124, 2.5 and 120 thousand head for buffaloes, cows, sheep, goat, camel and riding animal in 1999, respectively, which represent: 8.2%, 4.7%, 3.3%, 3.75%, 1.25% and 8.57% for buffaloes, cows, sheep, goat, camel and riding animal, respectively (NAI, 1999; AGRICULTURAL STATISTICS, 2001).

Animal production accounted for 30% of the total of agricultural production in Egypt, whereas meat and milk production accounted for 41%, and 26% of the total animal production in 1999, respectively of which 9.9%, and 6.2 of the total meat and milk produced in Menoufia (NAI, 1999). Livestock also serve as a store of wealth, source of draft power and fertilizer for crop production, and means of transportation. Since around 300 BC, animals have been used to drive the saqqiya (Egyptian water wheels), which lift irrigation water. Until recently, animals were also the principal source of non-human power in farming; they were used for cultivation, threshing, and transport, and farming families used the milk for home consumption. Animals were also important for their contribution to soil fertility. Their manure was invaluable, but also significant was the leguminous Egyptian clover, the principal fodder crop grown to support them. In combination with the annual

flooding of the Nile, animal manure maintained the fertility of the delta soils and thus supported the high rural population density (WARD, 1993).

The food problem in Egypt comes at the top of the problems, which the national economy suffers from. This situation arose from deficiency of the local food production to cover the ever-increasing consumption needs. As the result of this, a food gap arose and continued to increase year after year.

Animal production in Egypt is also exhibiting the same gap. The meat and milk Self-sufficient ratio (SSR) reached about 83% and 73% in 2000, respectively. The absolute per-capita consumption of meat and milk in 2000 reached about 16 and 81.45 Kg/year, respectively, while the average per-capita consumption of meat and milk in the developed world as a whole was 77 and 100 Kg/year, respectively (FAO, 2000). This means that, the absolute per-capita consumption of meat and milk in Egypt is still considerably lower, due to increasing the population growth rate in Egypt of 2.1% p.a. for the period 1986 to 1996. The total population reached 59.3 million inhabitants according to the result of last census 1996 (CAMPAS and NBE, 1998).

Egypt, as an example of a developing country, is facing a critical situation. Its agricultural production of major food commodities is increasing less rapidly than its consumption.

Accordingly, Egypt imports more than 50% of its consumed food and feed commodities. This inability to produce enough food and consequence on growth in food imports puts more pressure on the already unbalanced Egyptian economy. A primary institutional actor necessary to increase agricultural production and productivity in Egypt is the agricultural research and extension system in its role of developing and transferring improved technology to farmers. To date, however, there is little evidence that research and extension have been effective in increasing Egypt's production.

1.1 Research problem

The last decades of the twentieth century have showed many scientific progresses, which led to disseminate or diffuse many suitable technological innovations, contributed the development of animal production in Egypt. This scientific progress depends on: improvement feeding of animal, dissemination of genetic structures, improvement of animal health, marketing and storage of animal production (HATHOOT, 1991).

It becomes necessary to make changes in agricultural production, especially animal production through recent technological innovations, which requires continuous adoption of scientific knowledge in accordance with agricultural needs. (ABOU-TAHOON, 1993).

The success of an innovation to get adopted by farmers depends upon the suitability with respect to the specific area, soci-economic status of the farmers and know- how available to them. Traditional dairy farmers can become modern if they accept changes for that purpose and they must possess necessary knowledge and facilities for implementing the new practice. The wide socio-personal and economic differences existing among the farmers lead to the variation in the knowledge and adoption level of the dairy innovation among them. The suitability of an innovation also varies from farmer to farmer (SINGH et al., 1993).

The government exerted intensive efforts for diffusion and adoption of technological innovations. These efforts include: increasing the number of veterinary units and artificial insemination centers, diffusion of technological packages such as animal breeding, feeding, housing and management, and health. In addition, introduced efforts for diffusion and adoption of technological innovations were exerted from the administration of agricultural extension, administration of veterinary service, and animal production research institutes.

In spite of continuous efforts for diffusion of technological innovations in Egypt but the adoption results are not as desired, so that it's necessary to think and study the reasons why farmers to adopt or not adopt the technological innovations.

Previous studies about behavior of adopters of technological innovations show that existing socio-economic sociological factors and communication variables in general influence on the rate or level of adoption. The results of these studies show variations and differences.

Most pervious studies in Egypt concentrated in the last years on adoption of innovation in crop production, few of these studies concentrated on animal production innovations. It must be concentrated more studies on adoption of animal production to examine the factors influencing adoption of dairy innovation (BALI, 1996; SHAHIN, 1995; ELHABAL, 1989).

The scientific researchers indicate to improve the agricultural (crop and animal) production; it must apply new technology in agricultural sector with increasing interests in social and cultural environment at the same time with agricultural development, integration between agricultural research institutes, universities and agricultural extension. Research efforts have been expected to

concentrate on generating and developing new agricultural technology. However, these efforts have not resulted in major gains in agricultural productivity and in solving many of the production problems that Egypt's agriculture continue to face. Because of the agricultural Extension service was established in 1953 as a government tool to facilitate the transfer of new technology from research to farmers, however, technology transfer through the extension service appears to have been slow and inefficient. Furthermore, there is limited information about whether available technology is effectively transferred from research institutes to the extension service and concomitant feedback from extension to research.

Agricultural extension contributes to technology transfer and training system of farmers. This leads to progress of the agricultural development (SALAM, 1992).

Modern Agriculture "requires an innovative technology which systematically adopts scientific knowledge to farming" (SANDERS, 1977). In many countries farm–level technologies superior to those currently in use are already available. However, as experience as shown over the years, the gap between the existing level of technological knowledge and what is in use in a particular farm setting is not easily closed. Technological change is a difficult, time-consuming process, made even more difficult because many of the technology being promoted are not suitable to a particular locality, complementary services and delivery systems are not available, or unexpected cultural resistance often emerges among the intended beneficiaries (SOFRANKO, 1984).

One of the most important means of accelerating national development in economies with large agricultural sectors is the development, adaptation and evaluation of new agricultural technology that can be adopted by small farmers. This adoption can result higher incomes for small farmers, lower real prices of agricultural products for consumers, and greater economic efficiency and growth in the national economy. Therefore, the identification, development, adaptation, verification and farmer adoption of new agricultural technology as become an important part of the economic development strategies in many countries (KELLOGG et al., 1984; OMAR, 1992).

Studies have recorded a rather low level of milk and meat production, which is due to low knowledge and skills of cattle breeders', lack of extension services, lack of experience of farmers, lack of resource available to farmers and using traditional way of administration in the farm. Several organizations including international and national agricultural research centers, the World Bank, ministries of agriculture, and nongovernmental organizations have developed and promoted the use of improved dairy technologies to help increase farm productivity and smallholder income.

Yet the rate of adoption of these technologies among smallholder framers in Egypt remains low. The reasons for low adoption rates of improved dairy technologies are: characteristics of technology (relative advantage, compatibility, complexity, observability, trailability), farming conditions and characteristics of farmers such as social, economical, and psychological characteristics. The main aim of this study is to examine the adoption of innovations in smallholder Buffalo dairy farms in the Menoufia province in Egypt. The study also aimed at investigating the reasons for the adoption or non-adoption decision.

1.2 Objectives of the study

The objectives of this study are:

❖ To identify

- The communication channels or sources of information of innovations;
- The level of knowledge of smallholder buffalo dairy farms;
- The advantages or the reasons for adoption of innovations;

❖ To study

- The relationship between the farmers' characteristics, farm characteristics and adoption of innovations;
- The influence of innovation characteristics' on the rate and speed of adoption of innovations;

❖ To determine the reasons for non- adoption or discontinuance of innovations.

1.1 Conceptual framework

This study attempts to answer the following interrelated questions:

- Which sources of information of innovations are important?
- What are the characteristics of farmers who adopt innovations?
- How do characteristics of farmers and farm affect adoption?
- How do characteristics of innovations affect the rate and speed of adoption?
- How does an innovation diffuse through a society over time?
- What are the reasons for adoption and non- adoption of innovations?
- What are the advantages for adoption of innovations?

Several theoretical and empirical studies in diffusion and adoption of innovation have focused on these questions, especially in developing countries. These studies provide the foundation for the present study.

1.2 Organization of the study

This study intended to examine the adoption of innovations in smallholder Buffalo dairy farmers in the Menoufia province in Egypt. Beside the research problem and objectives, which have been already stated, this chapter presents the conceptual framework. Chapter 2 discusses problems of technologies with adoption, theories of technological change, and diffusion of innovations communications theory. Chapter 3 discusses the background and historical development of agriculture in Egypt, and research- extension-farmer linkages. Chapter 4 presents the material and methods of the study, including farming systems in Menoufia, location of the studied area, the study sites, sample procedures, identifying the case technologies, data collection and analysis, determinants of independent variables and, hypotheses for selected characteristics. Chapter 5 presents the results of the analyse, which include the influence of farmers' characteristics, and farm characteristics on the adoption of buffalo dairy innovations in the Menoufia province in Egypt and influence of innovation characteristics' on the rate and speed of adoption of innovations. Chapter 6 presents the summary and conclusions of the study.

2 Empirical basis of Adoption and change theories

2.1 Problems with Technologies and Adoption

In most developing countries, administrators are not obliged to attend periodical refreshment courses to update their knowledge of the changes in agricultural conditions and technology. It is really a problem of public administration management. Until this general problem is tackled, which may take along time, administrators can be exposed to the problems of modernization of agriculture, and the key role of extension in doing so, through short films, slide presentations, and simple readable books. It is equally important to associate national policies system at all levels with extension. The manner and degree of such association will, of course, vary among countries (VENKATESAN, 1984).

The links between agricultural research and technology transfer in developing countries are generally recognized as a major bottleneck in agricultural technology systems and have received inadequate attention in the past (STANDS, 1988). The linkage problem between agricultural research and extension arise from the differences in the nature of the two activities, in their objectives, and in the knowledge and resources they mobilize to achieve these objectives. Research is concerned with increasing scientific knowledge and generating new technologies. Extension is concerned with the delivery and adoption of new technologies; it relies upon communication, education and producer participation, with the overall aim of changing behavior (MARTINEZ, 1990).

The need for effective two-way linkages between agricultural research and extension is beyond dispute. Although agricultural researchers must have contact with farmers in order to be directly acquainted with their production conditions and technological requirements, they rarely have time for extended direct contact with farmers. Similarly, agricultural extension workers have little if anything to offer farmers in the long run without research input: existing farmer (and extension) knowledge and practice is a closed system that is unsustainable without input from research. Notwithstanding this mutual dependence of agricultural extension and research, in many places the linkages between them are weak (MICHAEL and THAWITZ, 1984).

One of the obstacles to foster agricultural output in the developing world is lack of effective agricultural extension education, which is a prerequisite to farmers' adoption of improved production technology. In many countries, the gap between available know farm technology in the

national and international research institutes and the extent of its application by farmers is very wide. This wastage in research efforts and great losses in agricultural output must be minimized if not completely avoided. The most urgent bridge needed for effective application of improved farm technology is for good agricultural extension and advisory services to be provided on a sustainable basis in the developing countries (ANGO, 2001).

Agricultural research organizations in developing countries confront many problems. These include lack of financial resources, acute shortages of well-trained scientists, lack of farmer feedback to insure relevance of research results, lack of access to external sources of knowledge, inadequate research facilities, low staff morale, and inadequate operating budget, staff incentives, and remuneration. Few of these can be addressed by extension managers, but they can impede generation of technology, resulting in fewer research outputs for extension to transfer. An understanding of research's problems is an important step in planning extension activities and coordinating them with research. Poor linkages between research and extension are major constraints in technology flow in many countries (KAIMOWITZ et al., 1989;ENGEL, 1990;EPONOU, 1993).

Problems can arise in transferring agricultural technologies, methods, and ideas between developed and less developed countries. While each situation is different, three barriers often have been encountered within developing countries:

- Lack of investment incentives: within a developing country, financial resources and incentives for private research investment may be lacking.
- Weak or nonexistent intellectual property rights: Inconsistencies in intellectual property rights (IPR) protection between countries have also been a barrier to technology transfer.
- Insufficient research capacity: The third barrier to technology transfer is the lack of a strong technology research capacity within many developing countries. Development of new technologies and practices is a complex process. Each innovation must be adapted to the specific characteristics of an application. (AGRICULTURAL OUTLOOK, 2002).

One of the major constraints of the extension agency in Egypt is the very small amount of feedback of agricultural practices and improved inputs coming from the farm into the extension and the research system. The dissemination of the results of agricultural research in the form of simple production recommendations suitable for widespread adoption by farmers is the corner-stone of agricultural development in any country. In Egypt, the recent years there have been considerable

research results but recommendations derived from these results have not spread into farmers` fields at a satisfactory rate. Increases in agricultural production have been much smaller than potential indicated by on-farm verification trails and a major contributing factor was the lack of coordination between research and extension. Other factors such as the lack of trained extension staff, the acute need for a specific work plan, and the absence of a clear educational philosophy, have also contributed to the slow rate of information dissemination among the farming community. Little research has been directed towards solving production constraints. Meanwhile, applied research has not been expended enough to reflect the major development objectives of vertical and horizontal agricultural expansion. Furthermore, the interrelationships among specialized institutes have been almost absent in research programs. The distribution of investment in the agricultural sectors has not been optimal and the relatively small amount of investment in agricultural research and extension programs has prevented improved technology being developed and made available to the farmer (LAMEY, 1998).

Also in Egypt there is shortage on research resources, and there is no prioritization of research areas or commodities that has been adopted. The country is in need for better defined research priorities in agriculture. Narrowing the food gap must become the major concern and ultimate target of any agricultural research activity. In addition to the above constraints, there is an acute shortage of transportation facilities, extension equipment, and aid as a result of the low budget. Incentive are inadequate to activate the extension system in order that relevant information be passed from researchers to farmers and information relating to farmers` problems be relayed back to research specialists (MANSOUR, 1988;ISMAIL, 1984,1989).

Agricultural technology has played, and will continue to play, a sustainable role in relation to the welfare of the small-farm sector. However, the issue of generation and transfer of technology have to be approached with caution and realism. In most cases, the lack of, or access to, technology is not the central element contributing to the poverty of small farmers. Access to the resources and other services is much more likely to be the major contributor. But even if improved technology alone will not solve the problem of rural poverty, it is undeniable that productive land use critical to welfare and appropriate technology is essential for this to improve. Past poor technological performance of the small-farm sector can be blamed in part on a piecemeal approach but did not consider the complexity of the situation. Often technology was, at best, a second or third option for solving problems. In addition, the institutions that generate technology failed to offer the small farmers viable options consistent with their needs and resources (MARTAIN, 1989). Some

problems are attributable to a lack of notional infrastructure, capital resources, or government policies set in the place to prevent technology transfer in the Arabic world (ROSE and STRAUB, 1998).

There is a distinct difference, however, between producers who are unable to adopt those who are unwilling to adopt. Nowak (1992) summarized these two types of barriers to adoption:

Inability to adopt: 1. Lack or scarcity of information; 2. High costs of obtaining information ; 3. Great complexity of the system 4. Too expensive; 5. Excessive labor requirements; 6. Planning horizon too short (benefits are far in the future); 7. Limited availability and accessibility of supporting resources; 8. inadequate managerial skill; and (9) little or no control over the adoption decision.

Unwillingness to adopt: 1. Information conflicts or inconsistency; 2. Poor applicability and relevance of information; 3. Conflicts between current production goals and the new technology; 4. Ignorance on the part of the farmer or promoter of the technology; 5. Inappropriate for the physical setting; 6. Increased risk of negative outcomes; and 7. Belief in traditional practices.

2.2 Theories of Technological change

Measuring technological change, which is defined as the shift of a production function over time, becomes harder if farmers can choose which production technology to adopt (VAN BIESEBROECK, 2003). Most technological change consists of incremental improvements of existing technologies and the diffusion of technologies that are integrated in existing production modes. Mainstream economics is well suited to deal with these issues, both in theoretical and empirical research. One can, for example, think of endogenous growth models addressing the controversies in the relationship between economic growth and the environment (AGHION and HOWITT, 1998;BOVENBERG and SMULDERS, 1995; SMULDERS, 1998). In reviewing different theories of the sources of technological change, RUTTAN (1997, 2001) points out that all the three approaches be considered - i.e. induced technical change, evolutionary theory, and path dependence- suffer major limitation if taken separately. For this reason he suggests integration of the three theories - in which the induced one plays the fundamental role - in order to construct a more general theory of technical change. DOSI (1997) proposes, challenging RUTTAN'S view, an evolutionary version of the induced theory and argue that the path-dependent account of innovation and technological change has to be integrated into the evolutionary theory, being the latter much

richer in the description and in the micro-foundation of the agent behavior. In this work he has tried to figure out how different theories explain the rate and the direction of technological change. All of them, in dealing with such a complex issue, show some limitations and flaws that have been discussed in this work. Indeed, he argue that the major challenge ahead in the construction of a more general theory of technological change is to attempt to disentangle the way in which one may influence the other and vice-versa.

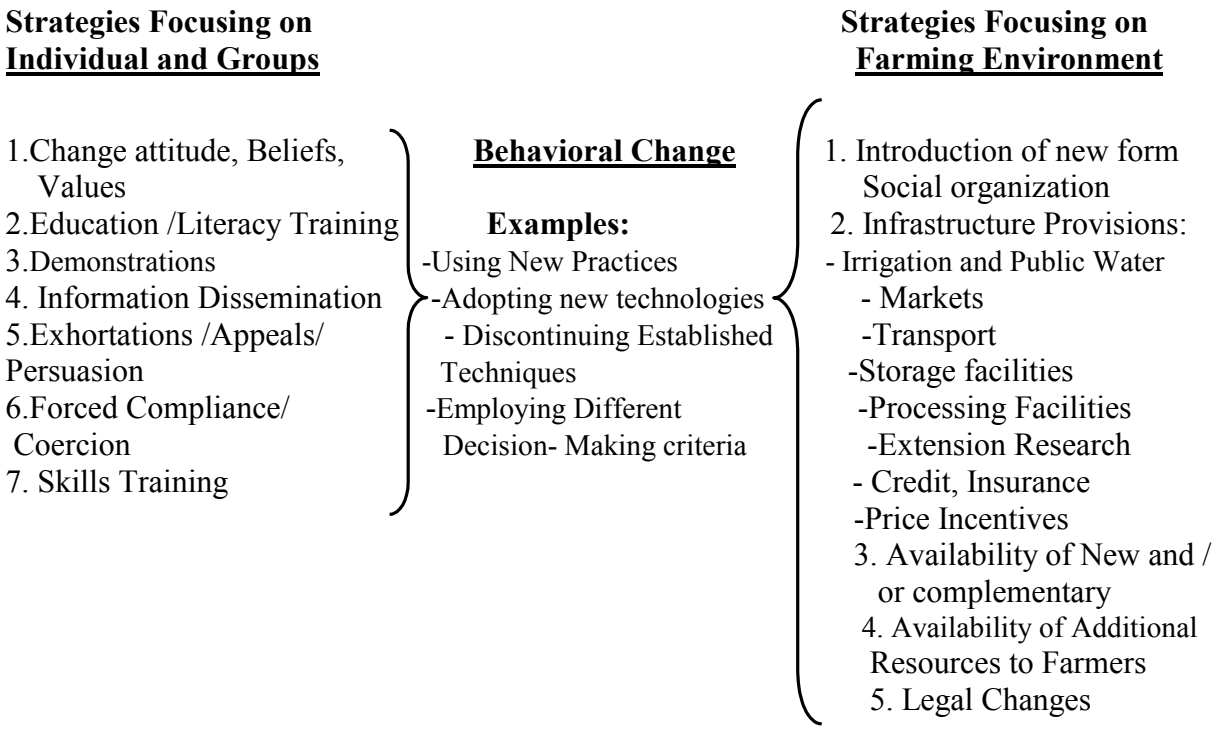
As argued by PAGANO (1999), the relationship between the characteristic of technology and of the institutional contest (in particular of the property rights) is a non-issue in neo-classical economics. Workers' or capitalist' ownership would have no effect on the characteristic of the technology employed by the firm. At the same time, the characteristic of the technology employed had no implication whatever on the ownership structure. All the decisions concerning technological change take place in an institutional vacuum. In SCHUMPETER'S theory technology change determines institutional change. In the Marxian framework two apparently contradicting theory of technological institutional change seems to co-exist. Indeed, Marx considers a two-way relationship between technology and institutions (e.g. property rights). The first one stresses the influence that of the ruling (optimal) technology on the institutional context. The second stresses the influence of the institutional context has on the characteristics of the resources and technology, which are employed and developed (PAGANO, 1999). The evolutionary approach is the one that is better equipped to account for and incorporate both technical and institutional change. Recently, initial attempts have been made to apply concepts from the evolutionary literature on technological change to the issue of environmental technological change. FREEMAN (1996) and KEMP (1997) provide a brief sketch of the way technology is dealt with in evolutionary economics and, consequently, its relevance for studying technological change in the context of sustainable development. A distinguishing feature of evolutionary theories on technological change stems from the used concept of technology (KEMP et al., 1994; RIP and KEMP, 1998). The evolutionary economic literature on technological change makes the important distinction between incremental and radical change in technology and technology systems. Incremental innovations are relatively minor changes of processes and products that occur more or less continuously (FREEMAN and PEREZ, 1988).

In many rural areas agriculture is still carried out with simple tools by traditional methods, using practices based on trial and error. The production of food is slightly increased. There is little question that changes must be made in production methods, and new technologies are increasingly

being viewed as the vehicle for solving agricultural problems. While the solutions seem to be simple, in practice it is not. Even where new technologies exist they may be inappropriate for particular agricultural settings, they cannot be transferred easily, or they collide with traditional cultural practices and preferences.

Developing agriculture by means of substituting new for existing technologies involves behavioral change on the part of the farmer. The amount of change involved will depend of the technologies and practices being promoted and the extent to which farmers` current behavior is inconsistent with them (SOFRANKO, 1984). Strategies for bringing about change have generally focused on altering the environment in which agriculture is carried out, or in the direct transformation of farmers themselves. These two contrasting strategies are shown in Figure 1 (Rogers, 1969).

Figure 1. Contrasting Approaches to Behavioral Change among Farmers



2.3 Definitions of technology adoption

Egypt has exerted a great deal of efforts to improve agricultural technology transfer as a means to increase its agricultural production during the last decades. New agricultural technology is generally a bundle or package of different technological elements such as improved varieties, fertilizers, pesticides, and machines; plus the technical practices and skills needed for their effective use (SAMY, 1998).

Technology

Any definition of technology encompasses a wide range of phenomena. In the broadest sense, technology is defined as the translation of scientific laws into machines, tools, mechanical devices, instruments, innovation, procedures and techniques to accomplish tangible ends, attain specific needs, or manipulate the environment for practical purposes (THEODORSON and THEODORSON, 1969).

Innovation

An innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". More than five characteristics of innovations are identified and they help explain the differences in adoption rates (DASGUPTA, 1989; ROGERS, 1995).

Agricultural Technology

Agricultural technology consists of the two following components (ROGERS, 1983,1995):

- A hardware aspect, consisting of the tool that embodies the technology as a material or physical object such as fertilizers, pesticides, machineries; and
- A software aspects, consisting of the information base for the tool such as technical knowledge and skills about how to use the hardware aspect of technology.

Technology Transfer

Technology transfer is defined as the process, by which a body of knowledge passes from research to extension, is tested, reviewed, and evaluated at various stages in terms of practical usage (NAGEL, 1979; SWANSON 1997).

Diffusion

Diffusion is the process by which an innovation is communicated through certain channel over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding. This definition

implies that communication is a process of convergence (or divergence) as two or more individuals exchange information in order to move toward each other (or apart) in the meanings that they give to certain events. They think of communication as a two-ways process of convergence, rather than as a one-way, linear act in which one individual seeks to transfer a message to another in order to achieve certain effect (ROGERS and KINCAID, 1981). A linear conception of human communication may accurately describe certain communication acts or events involved in diffusion, such when a change agent seeks to persuade a client to adopt an innovation. But when we look at what came before such as event, and at what follows, we often realize that the event is only one part of a total process in which information is exchanged between the two individuals.

Diffusion is a special type of communication, in which the messages are about a new idea. This newness of the idea in the message content gives diffusion its special character. The newness means that some degree of uncertainty is involved in diffusion. Uncertainty is the degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probability of these alternatives. Uncertainty implies a lack of predictability, of structure, of information. In fact, information is a means of reducing uncertainty. Information is a difference in matter-energy that affects uncertainty in a situation where a choice exists among a set of alternatives (ROGERS and KINCAID, 1981).

Diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of social system. When new ideas are invented, diffused, and adopted or rejected, leading to certain consequences, social change occurs. Rogers (1995) states that there are four main elements of diffusion which including: Innovation, time, communication, and social system.

Innovation-Decision Process

The adoption of new technology is not an instantaneous act, but it is a complex process and also takes time. Furthermore, adoption is mental process wherein farmer will have to pass from first hearing of technology packages, to form an attitude either favorable or unfavorable and a decision to adopt or reject, to implement the decision taken on limited scale and to confirm the decision to adopt the new technology continuously (HULAGUR and GANGDHARAPPA, 1999).

2.4 Adoption/Diffusion theories

2.4.1 Innovation Decision Process

The North Central Rural Sociology Subcommittee for the study of diffusion of farm practices (ROGERS and SHOEMAKER, 1971) had developed the traditional well known adoption process which views adoption as a series of stages. According to this committee, individuals do not adopt any innovation immediately after they hear about it. They normally need sometime to adopt. Such a time might continue for several years before even trying to implement the idea for the first time. The adoption process, as viewed by the committee is composed of five stages which are:

- **Awareness stage**: The individual hears about the existence of the new idea for the first time but lacks information about it.
- **Interest stage:** Out of curiosity and interest, the individual tries to gather more information about the idea.
- **Evaluation stage:** The individual makes a mental judgment taking into consideration both the merits of the new idea and his existing situation and condition. Such an evaluation ends normally in a decision either to try the new idea on a small scale or to reject it.
- **Trail Stage:** Trail means implementation of the new idea or innovation on a small scale. For example the farmer who normally cultivates five feddans of particular crop might try to cultivate only half Feddan from the new Varity of the crop.
- **Adoption stage:** After the idea is examined, and its feasibility is tested, the farmer or the individual well try to implement such an idea on a full scale. Implementation on a full scale is conceptualized as adoption.

After publishing the five stages of adoption process, many research studies were launched to examine the validity of these stages. Some studies ended using three stages and some other studies ended using four stages, while a third group of studies use six or more stages of adoption.

The five stages process of adoption was also characterized by other logical and empirical basis. First: The process does not always end in adoption. Rejection is likely to happen at any time and at any stage of the process. Second: To adopt, the individual does not need to pass through the five stages of the process in the same order previously mentioned. Some of these steps may be omitted. Also evaluation may happen at any stage (ROGERS and SHOEMAKER, 1971).
Rogers' Innovation Decision Process theory states that diffusion is a process that occurs over time and can be seen as having five distinct stages. The stages in the process are:

1. Knowledge stage: At this stage the individual exposed to an innovation's existence and he also obtains some information related to how the idea functions. Major source of knowledge are formal and technical education, as well as information provided by the change agent and mass media. An innovation typically contains software information, which is embodied in the innovation and which serves to reduce uncertainty about the cause-effect that is involved in achieving a desired outcome. Questions such as "What is the innovation?" "How does it work?" And "Why does it work?" Are the main concerns of an individual about an innovation? There are three types of knowledge:

- **Awareness knowledge:** Awareness knowledge is information that an innovation exists. Awareness-knowledge then motivates an individual to seek "how -to" knowledge and principle knowledge. This type of information –seeking is concentrated at the knowledge stage of the innovation-decision process, but it may also occur at the persuasion stages.
- **How -to knowledge:** How -to knowledge consists of information necessary to use an innovation probably. In the case of innovations that are relatively more complex, the amount of how-to knowledge needed for proper adoption is much greater than in the case of less complex ideas. And when an adequate level of how-to knowledge is not obtained prior to the trail and adoption of an innovation, rejection and discontinuance are likely to result.
- **Principles - knowledge:** Principles - knowledge consist of information dealing with the function principles underlying how the innovation works.

2. Persuasion stage: At the persuasion stage**,** the farmer forms a favorable or unfavorable attitude toward the innovation. Whereas the mental activity at the knowledge stage was mainly cognitive, the main type of thinking at the persuasion function is affective.

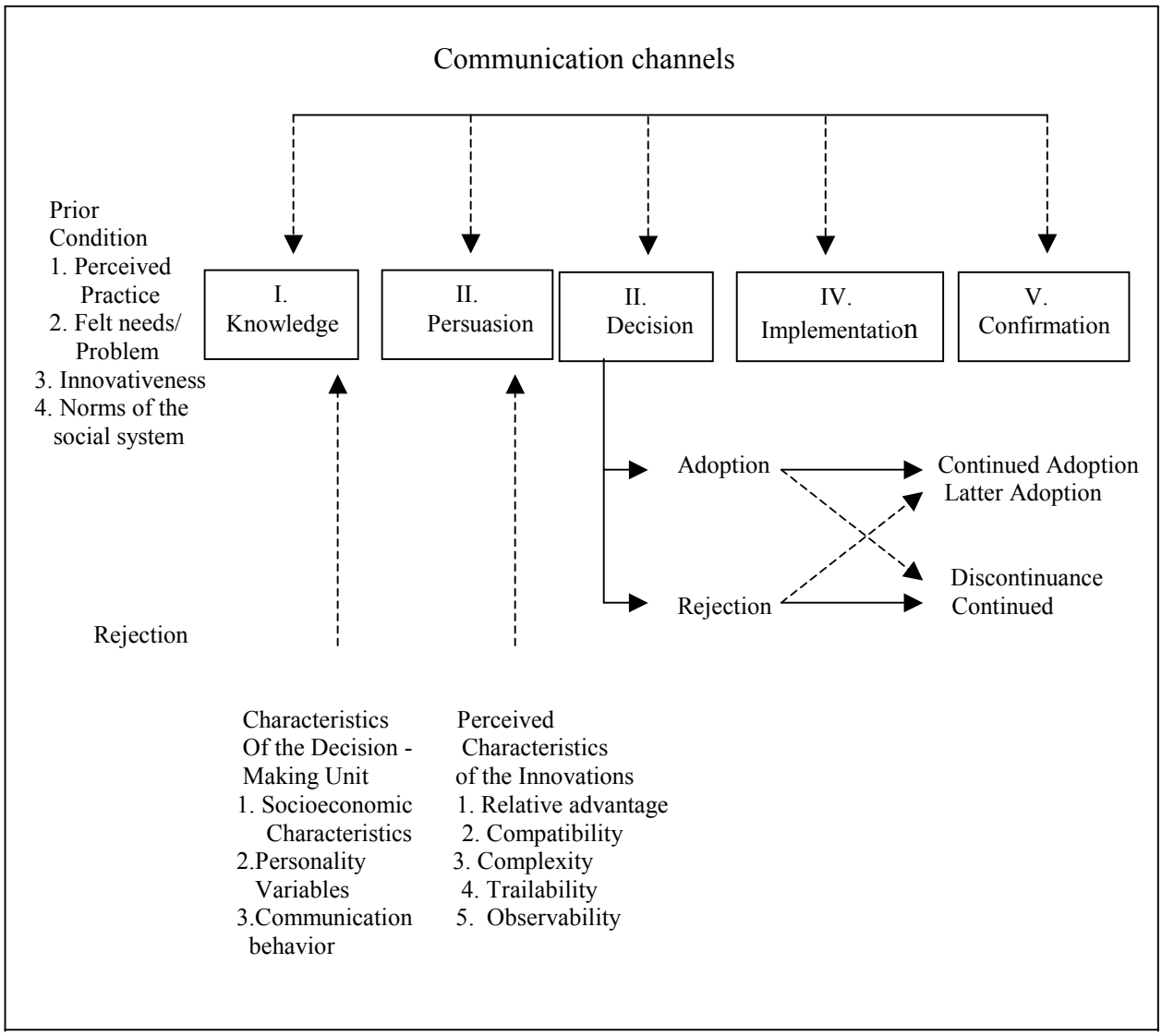
3. Decision stage: The decision stage in the innovation decision process when an individual engages in activities that lead to a choice to adopt or reject an innovation. Adoption is a decision to make full use of the best course of action available. Rejection is a decision not to adopt an innovation.

4. Implementation stage: In the implementation stage, the individual puts an innovation into use. Until the implementation stage, the innovation decision process has been strictly mental exercise. But implementation involves overt behavior changes as the new idea is actually put into practice.

5. Confirmation stage: It should be noted that the decision to adopt or reject is not the end of the innovation decision process. After the decision, the individual normally seeks more information about the new idea. This information might confirm his decision or reverse it. So if the newly collected information about the idea confirms his decision of adoption, the decision maker will

continue implementing the new idea. On the other hand, if such information does not support his adoption decision, he will tend to discontinue using the idea. The newly collected information about the idea might help in changing the person's decision from rejection to adoption. The model of in the innovation-decision process as shown in the (Figure 2).

Figure 2. A model of Stages in the Innovation –Decision Process



Source: Rogers (1995)

Abdel Maksoud (1977) presented another model describing the process of the innovation decision making. This model consists of three main stages which are : 1) Recognization of the problem or aim motivation, 2) Assessments of alternatives and selection of the best , 3) Integration of decsion taken.

Some other models were reviewed by Shaker (1984). He presented Smith model consisting of four stages which are: 1) Information seeking , 2) Conviction , 3) Decision , 4) Action , which includes the two steps trail and adoption , and finnally 5) Confirmation.

2.4.2 Perceived Attributes

Rogers (1995) suggested five attributes of innovations, which are relevant to adoption and diffusion of technologies such a classification system should be applicable to different types of technologies, the categories of technology characteristics are general:

1. Relative advantage: Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. Relative advantage indicates the benefits and the costs resulting from adoption of an innovation. The subdimensions of relative advantage include the degree of economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving in time and effort, and the immediacy of the reward or other benefits. Relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption (ROGERS, 1995).

2. Compatibility: The compatibility of an innovation is perceived in terms of its consistency with the existing values, past experience, and needs of potential adopters. Physical compatibility refers to the degree which a new idea or practice is consistent with existing practices relating to economic activities (Dasgupta, 1989). An idea that is more compatible is less uncertain to a potential adopter. According to the communication approach, compatibility is assumed to be positively related to adoption (ROGERS, 1995).

3. Complexity: Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. An innovation, which is relatively simple to understand and use, diffuses quickly. Diffusion of an innovation, which is too complex to communicate and to apply, is slow. Rogers (1995) assumes that the complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption.

4. Trailability: Trailability (or divisibility) refers to the degree to which an innovation can be tried out by the farmer on a limited scale before deciding to adopt it. Trailability of an innovation is important for its diffusion for several reasons. The feeling of insecurity associated with the adoption of something new and previously unknown is greatly minimized if it can be tried out on a small scale. The result of the trail, if successful, not only minimize the risk and insecurity, it is also gives the farmer the opportunity to evaluate the innovation (DASGUPTA, 1989). Divisible Technologies can be adopted more rapidly than Technologies that are not divisible. Trailability of

an innovation, as perceived by members of a social system, is positively related to its rate of adoption. (ROGERS, 1995).

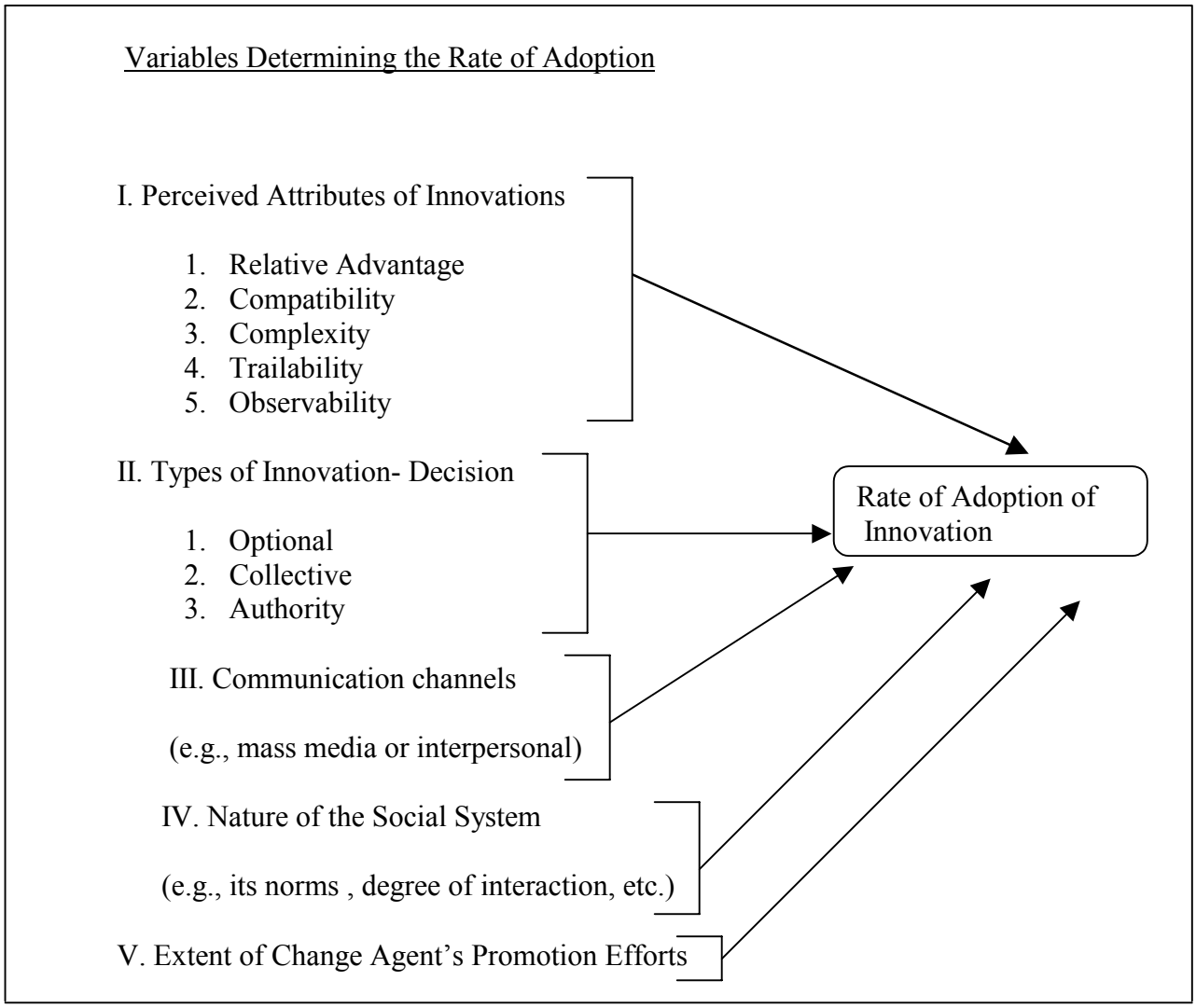
5. Observability: Observability is the degree to which the results of an innovation are visible to others. The result of some new ideas are easily observed and communicated to others, can be adopted more rapidly than ideas that are difficult to observe or to describe to others. The observability of an innovation, as perceived by members of a social system, is also assumed to influence adoption. (ROGERS, 1995).

2.4.3 Rate of Adoption

Rate of adoption is the relative speed with which an innovation is adopted by members of a social system. The rate and speed of adoption are determined by at least five factors as shown in Figure 3.

1. Perceived attributes of innovation. It is assumed that innovation is adopted faster if they show greater relative advantage, compatibility, Trailability, observability and low complexity.
2. The type of innovation–decision. It is related to an innovation's rate of adoption. Innovations requiring an individual-optimal innovation-decision are generally adopted more rapidly than when an innovation adopted by groups.
3. Communication channels used to diffuse an innovation influence the innovation's rate of adoption by spreading knowledge. Using of mass media channels spread the knowledge faster than interpersonal communication. Mass media channel, were satisfactory for less complex innovation. But interpersonal communication was more important for innovations that were perceived by farmers as more complex.
4. The social system influences the adoption rate, through its social and cultural norms. Innovation that is not compatible with the social system will not be adopted.
5. The extent of change agents` promotion efforts. An innovation's rate of adoption is also affected by the extent of change agents` promotion efforts. One factor in change agent success is the amount of effort spent in communication activities with clients. A major function of extension practitioners is to facilitate the adoption of new ideas and practices or to influence the rate of diffusion and adoption of innovations by their clients. To enhance their effectiveness as change agents, extension practitioners must understand the unique characteristics that describe their clientele system.

Figure 3. Determining the Rate of Adoption



Source: Rogers (1995).

2.4.4 Individual Innovativeness

Innovativeness: Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. There are five adopter categories, or classifications of the members of a social system on the basis on their innovativeness:

1. Innovators: Innovators (Venturesome) are the first 2.5 percent of the individuals in a system to adopt an innovation. Venturesomeness is almost an obsession with innovators. This interest in new ideas leads them out of a local circle of peer networks and into more cosmopolite social relationships.

2. Early adopters: Early adopters (Respect) are the next 13.5 percent of the individuals in a system to adopt an innovation. Early adopters are the more integrated part of the local system than are innovators. Whereas innovators are cosmopolites, early adopters are localities.

3. Early majority: Early majority (Deliberate) is the next 34 percent of the individuals in a system to adopt an innovation. The early majority adopts new ideas just before the average member of a system. The early majority interacts frequently with their peers, but seldom hold positions of opinion leadership in a system. The early majority's unique position between the very early and the relatively late to adopt makes them an important link in the diffusion process.

4. Late majority: Late majority (Skeptical) is the next 34 percent of the individuals in a system to adopt an innovation. The late majorities adopt new ideas just after the average member of a system. Like the early majority, the late majorities make up one-third of the members of a system.

5. Laggards: Laggards (Traditional) are the last 16 percent of the individuals in a system to adopt an innovation. Laggards tend to be suspicious of innovations and change agents. Resistance to innovations on the part of laggards may be entirely rational from the laggard's viewpoint, as their resources are limited and they must be certain that a new idea will not fail before they can adopt.

2.5 Factors affecting on adoption

Adoption of agricultural technologies in developing countries are influenced by a wide range of economic and social factors as well a physical and technical aspects of farming and risk attitudes of farmers (KEBEDE et al., 1990). The suitability of an innovation depends on the potentialities of the farmers. i.e. their personal attributes like attitude, values, beliefs, farm size, education, extension contact, communication behavior and so on. The farmers always differ in their socio-economic status as well as in personal traits. Hence, there is a possibility that different categories of farmers might adopt the technologies to different extent (SINGH et al., 1993). It is important to understand the role of these factors to help develop appropriate technologies. The impacts of household characteristics, Farm characteristics and farmers` resource endowments institutional support systems on adoption of technologies are discussed below (Table 1).

Table 1. Literature summery on affect of independent variables on the adoption of various technologies

Author	Country	Technology	Age	Education	Household size	Her size	Income	Wealth	Veterinarian	Extension	Farm size	Labour	Social part	Cosmopolite	Mass media
Animal production															
Bulale(2000)	Ethiopia	Concentrate	ns	+	ns					ns	+				
Bulale(2000)	Ethiopia	Forage	ns	ns	ns					ns	ns				
Bulale(2000)	Ethiopia	Fencing	ns	ns	+					ns	ns				
Bulale(2000)	Ethiopia	Bucket feeding	ns	ns	ns					ns	ns				
Bulale(2000)	Ethiopia	Cowshed	ns	ns	ns					ns	+				
Bulale(2000)	Ethiopia	AI	ns	ns	-					ns	ns				
Batz (1999)	Kenya	Concentrate		ns	ns						ns	ns			
Batz (1999)	Kenya	Cowshed		+	ns						+	ns			
Batz (1999)	Kenya	Fencing		ns	ns						-	ns			
Batz (1999)	Kenya	Calf pen		ns	ns						+	+			
Batz (1999)	Kenya	Bucket feeding		ns	-						ns	ns			
Batz (1999)	Kenya	Milking place		+	ns						ns	+			
Batz (1999)	Kenya	Dipping		ns	+						ns	ns			
Batz (1999)	Kenya	Spraying		ns	+						ns	ns			
Waithaka (1998)	Kenya	Milking place		ns	ns						ns	ns			
Waithaka (1998)	Kenya	Minerals		ns	ns						ns	ns			
Waithaka (1998)	Kenya	Concentrate		ns	ns						+	ns			
Waithaka (1998)	Kenya	Dewaming		ns	ns						ns	ns			
Waithaka (1998)	Kenya	Spraying		ns	ns						ns	ns			
Shahin (1995)	Egypt	Knowledge (A.P)	ns	ns	-	+		+	+	ns			ns	+	+
Shahin (1995)	Egypt	Adoption (A.P)	ns	ns	-	+		+	+	ns			+	+	+
Shahin (1995)	Egypt	Continuous (A.P)	ns	ns	-	+		+	+	ns			+	+	+
Mahmoud (1994)	Egypt	Animal production	-	+				+		+	+			+	+
Gad-Al-Rab and Shalaby (1997)	Egypt	Breeding	-	+	+	ns								ns	+
El-Melegi (2000)	Egypt	Breeding , manag	+	+	+	+	+		+			ns			
Hafz and Anwar (1999)	Egypt	Husbandry		ns	ns	+			+	+			ns		+
Salama (2001)	Egypt	Animal production	ns	+	+	+		+	+	ns			+	+	
El-Habal (1977)	Egypt	Animal production	ns	+	+	+	+	+	+	+			+	+	
El-Habal and Osman (1989)	Egypt	Animal Production			+	ns			+	ns				+	
Bali (1996)	Egypt	Animal Improve	ns	+	+	+		+	+	+	ns		+	ns	+
El-Mekawy(1996)	Egypt	Animal production	ns	+		+	+		+	+	+		+	+	+
Barham et al (2004)	Wisconsin	rbST		ns		+									
Klotz (1995)	California	rbST		+	+	+									
Foltz and Chang (2002)	India	rbST	-	+	+	+									
Singh and Sharma(1995)	India	Dairy Farming	ns	+	+	+	ns			+			ns		+

Table 1. Continued

Singh et al.(1993)	India	Breeding	ns	+		+	+			+	ns		+		+
Singh et al.(1993)	India	Feeding	ns	+		ns	ns			+	ns		ns		ns
Singh et al.(1993)	India	Healthy Care	ns	+		+	+			+	ns		ns		ns
Singh et al.(1993)	India	Management	ns	+		+	+			+	+		+		ns
Madhukar and Ram(1996)	Niger	Dairy Farming	+	ns		+	ns			+	ns		ns		+
Saha et al. (1997)	Texas	bsT	+	+			+								
Mohamed 1996	Egypt	Milk Production			ns						+				
Yossef (1981)	Egypt	Dairy Farming	ns	+	+	ns		ns					+	+	+
Jabbar et al. (1998)	Ethiopia	BBM	ns	ns	+	+									
Hamada and Asmat (1994)	Egypt	Animal Production		+		+									
Abou El-Shahat (1992)	Egypt	Animal Production	ns	ns	+	+		+					+	+	+
Goswami et al. (2001)	India	Vacc Against Bro											ns	+	+
Goswami et al. (2000)	Bengal	Animal Husbandry			ns								ns	+	+
Kebede et al. (1990)	Ethiopia	Single-Ox		ns /+	- /n s	ns /+	ns /n s				ns				
Fish production															
Sakr (1998)	Egypt	Fish Culture			+										
El-Ghamrini1998	Egypt	Fish	ns	ns			ns			ns			+	+	+
Al-Habal (1990)	Egypt	Fish Breeding	ns	+	+			+		+				+	
El-Abasy (1995)	Egypt	Aquaculture			+								+	+	+
El-Ghamrini (1996)	USA	Aquaculture	ns	ns										+	
Honey production															
El- Mohakel (1990)	Saudi A	Bee	ns	+											
Crop production															
Gad-Al-Rab (2000)	Egypt	Agric. Innovations	+	+	+					+					+
Mahmoud (1994)	Egypt	Agric Machinery	-	+				+		+	+		ns	+	+
Mahmoud (1994)	Egypt	Plant production	-	+				+		+	+			+	+
Mahmoud (1994)	Egypt	Chemical	-	+				+		+	+			+	+
Ransom et al.(2003)	Nepal	Improved Maize	ns	ns			+			+		-			
El-Habal 1995	Egypt	Crop	+	+	+		+	+					+		+
Al-Sakran (2001)	Saudi A	Cultivating palm	+	+	+		ns				+	ns		+	
Shibah et al.(2002)	Saudi A	Irrigation		ns	+						+	+		ns	
Mizher (2002)	Iraq	Wheat crop	-	+	-	+	+	+				ns			
Abd El-Razek (2002)	Iraq	Wheat crop	-	+	-	+	+	+		+		ns			+
El-Esawi 1993	Egypt	S. Agric. Project		+	+								+		
El-Maghawry (1994)	Egypt	Agric Machinery			+		+	+				-	+	+	
Salama (1983)	USA	IPM	ns	+	+		+								
Sakr (1998)	Egypt	Wheat			ns										
Sakr(1998)	Egypt	Bean			+										
Abdelmagid and Hassan(1996)	Sudan	Fertilizer Use	ns /+	+/ +	- /+					+/ +					
Abdelmagid and Hassan(1996)	Sudan	Improved Wheat	ns /+	ns /-	ns /n s					+/ +					

Table 1. Continued

Abdelmagid and Hassan(1996)	Sudan	Land Preparation	ns /+	ns /-	ns					+/ +					
Getahun et al.(2000)	Ethiopia	Improved Maize	+	ns	+		+			ns	+	ns	ns		
Getahun et al.(2000)	Tanzania	Fertilizer	-	ns	+	+	+			+	+	ns	ns		
Mussei et al. (2001)	Tanzania	Improved Wheat	-	ns	ns	+	+			+	+	ns			
Mussei et al. (2001)	Connecticut	Fertilizer	-	ns	ns	+	+			ns	+	ns			
Zeller et al. (1998)	Malawi	Hybrid Maize		ns	ns						ns				
Zeller et al. (1998)	Malawi	Tobacco		ns	+						+				
Zeller et al. (1998)	Malawi	Local Maize		-	-						+				
Kebede et al. (1990)	Ethiopia	Pesticides		ns /+	+/ +	ns	+/ ns				+/ +				
Kebede et al. (1990)	Ethiopia	Fertilizer		ns	+/ +	ns	ns				+/ +				
Shiyani et al. (2002)	India	Chickpea		+	ns										
Baidu-Forson (1999)	Niger	Improved Soil	ns							+					
Adesina and Baidu-Forson (1995)	Burkina Faso	Variety, Sorghum	+		ns					+					
Adesina and Baidu-Forson (1995)	Guinea	Variety, Rice	ns		ns					ns					
Lapar and Pandey (1999)	Philippine	Soil Conservation	ns /-	+	ns /+								+/ +		
Adesina and Zinnah (1993)	Sierra Leone	Variety	ns							+					
Ayuk (1997)	Burkina Faso	Live Hedges	+	ns			+					+			
Barsoum (1988)	Egypt	Corn-Giza II	ns		ns	+					ns		ns	ns	
Negatu and Parikh (1999)	Ethiopia	Improved Wheat			+		+								
Goodwin & Shroeder (1994)	Kansas	Variety		ns	ns										
Sallam and Moustafa (1999)	Egypt	Irrigation	ns	ns											
Abdel-Kader and Moursi (1992)	Egypt	Corn Varieties	ns	+	+						ns				
Soma and Bali (1999)	Egypt	IPM	ns	ns	ns			+					ns	+	
El-Melegi and Rafee(1998)	Egypt	Banana	+/ +	+/ +	+/ ns					+			+/ ns		
El-Gannam (2000)	Egypt	Cotton	+	+		+	ns				ns				
El-Gannam (2000)	Egypt	Wheat	+	+		ns	+				+				
El-Gannam (2000)	Egypt	Rice	+	+		ns	+				+				
El-Gannam (2000)	Egypt	Corn	+	+		-	ns				+				
Sorour (1996)	Egypt	Variety	ns		ns					ns			+	+	+
Al-Shathily and Abed(1987)	Iraq	Variety		+			+	+		ns	ns		+	+	+
Abd El-Wahed (1999)	Egypt	Irrigation	ns		+			+		+			+		+
Sakr (2001)	Egypt	Wheat	ns	+	ns			+		+				+	
Sakr (2001)	Saudi A	Sugar-Beet	-	+	ns			+		+				+	
Elnassar and Razik (1986)	Saudi A	Date Palm		+	-	+				+	+				
Abdel Maksoud (1985)	Egypt	Mechnization		+	+	+					ns		+	+	
Abdel Maksoud and Elnassar (1987)	Egypt	Variety	ns	ns	ns	+				+	ns		ns	+	

Table 1. Continued

Shibah and Abdel-Rahman (1990)	Saudi A	Wheat	+	+	ns			ns		ns				ns	
Cheikh (1996)	Syrian	Green Houses	ns	+	+		+				ns		+	+	+
Hassanien (2000)	Egypt	IPM	ns		ns							ns			
Yassa (1983)	Egypt	Variety	ns	+	+	+	+				+	-	+	+	+
Abo- Halima 1986	Egypt	Tomato	-	+	-		+						+	+	
Abou- Khatwa (1974)	Egypt	Lentil	ns	+	+						+				
El-Hanafy (1974)	Egypt	Olive	ns	+	+						ns		ns	ns	
El- Kady (1975)	Egypt	Cotton	ns	+	+						+		+	+	+
El-Shathily (1977)	Egypt	Variety	ns	+	+					+	+		+	+	+
Salem (1987)	Egypt	Soybean	ns	ns	+			+			ns			+	
El-Kateeb (1984)	Egypt	Mechanization	+	+	+	+	+				ns			+	
Bakheit (1986)	Egypt	Arum	+	+	+		+				+	+			
Mohamed And Abul- Ez (1984)	Egypt	Coffee	+		+						+				
Shalabi (1988)	Egypt	Rice			Ns						ns			+	
Towfik (1988)	Egypt	Water		ns									+	+	
Ahmed (1994)	Egypt	Sun Flowers	ns	+	+			ns		ns	+		ns	ns	ns
Abdel-Guid (1998)	Egypt	Wheat		+									+	+	+
Hossein (1998)	Egypt	Cotton	ns	+							ns		ns	ns	
Allam (1986)	Egypt	Surdan Forage	ns	ns	+	ns					+		+		
El-Tantawy (1998)	Egypt	Cotton	-	+				+		+	+		+	+	
Ibrahim (1989)	Egypt	Vaiety	ns	+	+										
Abou-Atab (1978)	Egypt	Variety	ns	+	+								+	+	
Dahab (1986)	Egypt	Soybean	ns	+	+	ns							ns	+	
O` Brien et al. (1996)	Russein	Mechanical	+								+				
El-Shathily (1992)	Egypt	Rice	-	+	+					+	+				+
Osman (1986)	Iraq	Vegetables	ns	+	Ns			+		+	ns		ns	+	
Aboul-Ez (1991)	Egypt	Soybean	-	+	+		+			+			+	+	+
Mohamed (1994)	Egypt	Forage cultivation		+		ns									
El-Shathily and El-Nour (1988)	Egypt	Variety	+	+			+				+		+	+	
El-Shathily and Azmy (1988)	Egypt	Arum	ns								ns			ns	
Radwan and Salma (1990)	Egypt	Variety		+									ns		+
Abou El-Shahat (1990)	Egypt	Cotton	ns	ns	+			-	+	+			+	+	+
Bembridge and Tshikolomo (1998)	Phaswana	Variety					+				+				+
Yossef (1989)	Egypt	Sugar beet											ns	+	+
Byerlee and Planco (1982)	Mixico	Tractor, drill			+										
El-Ghamrini et al.(1995)	USA	Telecommunications	ns	ns											
Abd-Ella et al(1981)	USA	Farm System			+					+			+	+	

ns =not Significant; + = Significant positive relationship ; - = Significant negative relationship
/ = Result of the same study but from different site. Source Own Complication

1. **Age of farmer**

Age of farmers is the most frequently reached personal characteristics whose influence on adoption behaviour has been examined in a large number of studies.

The findings on the relationship between the age of farmers and their adoption behaviour are somewhat inconsistent. Fifty-nine out of the 99 studies reviewed and complicated in Table 1, reported no relationship between age and adoption. While 23 reported a statistically significant positive relationship between the two variables. Even 17 studies that found a statistically significant negative relationship between them.

For example BULALE (2000), SALAMA 2001, Bali (1996), ABDELMAGID and HASSAN (1996), SINGH and SHARMA (1995), ADESINA and BAIDU-FORSON (1995) and, SHIBAH et al. (2002) reported no relationship between age and adoption. The studies by El-MELEGI (2000), GETAHUN et al. (2000), GAD-AL-RAB (2000), AL-SAKRAN (2001), MADHUKAR and RAM (1996), SAHA et al. (1994), O` BRIEN et al. (1996) found a statistically significant positive relationship between the two variables. While the studies by MIZHER (2002), MUSSEI et al. (2001), FOLTZ and CHANG (2002), LAPAR and PANDEY (1999), reported a statistically significant negative relationship between them. In spite of the above mentioned trends, the majority of the studies conducted in the adoption area did not indicate a statistically significant relationship between age and innovation adoption. ROGERS (1995), for example, reported that about half of 228 studies which reviewed on this subject, indicated no relationship between age and adoption.

Household size

There is a disagreement between the research findings in relation to household size as an important factor affecting the adoption process. 40 out of 106 studies found no relationship between household size and adoption (Table 1). While 58 reported a statistically significant positive relationship between the two variables. Even 12 studies that found a statistically significant negative relationship between them.

BULALE (2000), MUSSEI et al. (2001), ZELLER et al. (1998), BATZ (1999), MADHUKAR and RAM (1996) reported no relationship between household size and adoption. The studies

carried out by MUSSEI et al. (2001), KEBEDE et al. (1990), BEMBRIDGE and TSHIKOLOMO (1998), and SHIBAH et al. (2002) found a statistically significant positive relationship between the two variables. While the studies by GETAHUN et al. (2000), KEBEDE et al. (1990) reported a statistically significant negative relationship between them.

Level of education

There is an agreement among writers and researchers that education is a very important factor in determining the adoption rate of farmers.

The overwhelming majority of studies (72 out of 120) found a statistically significant positive relationship between education and the adoption behaviour of farmers (Table 1). These studies also found that the proportion of literates or individuals with a higher level of education was greater among earlier than later adopter. Three studies reported a statistically significant negative relationship between education and the adoption, While (45 out of 120) studies found no relationship between them.

A good number of these studies have listed education as one of the most important factors affecting on adoption. BULALE (2000), ABD EL-RAZEK (2002), Bali (1996), FOLTZ and CHANG (2002), and SINGH and SHARMA (1995) found a statistically significant positive relationship between education and the adoption. But the studies by ABDELMAGID and HASSAN (1996), and ZELLER et al. (1998) reported a statistically significant negative relationship between education and the adoption. While the studies by BULALE (2000), GETAHUN et al.(2000), MUSSEI et al. (2001), and WAITHAKA (1998) found no relationship between education and the adoption. Only 3 studies, found a statistically significant, negative relationship between them.

Farm size

Most studies handling this factor reported a significant relationship between farm size and adoption. ROGERS (1995) for example, had generalized that: “Earlier adopters have larger units (farm, companies, and so on) than later adopters”.

Forty-two out of 76 Studies, which examined the relationship between the two variables, found that the size of farm owned or operated by a farmer was positively related to his adoption behavior (Table 1). On other hand few studies (2 out of 76) found the size of farm, negatively and significantly influenced the adoption of technologies. Thirty-three studies indicated that there is no significant relationship between adoption and farm size. Few studies, observed differential effects of farm size on adoption. Examples of these studies were, FOLTZ and CHANG (2002), EL-MELEGI (2000), GETAHUN et al. (2000), NEGATU and PARIKH (1999), and JABBAR et al. (1998) found that the farm size was positively related to his adoption. BULALE (2000) working on the adoption of dairy production technologies in Ethiopia found differential effects of farm size on adoption of dairy production technologies. Farm size, positively and significantly influenced the adoption of pasture fencing but did not affect of five technologies. KEBEDE et al. (1990), in a study on the adoption of single-ox, pesticide, and fertilizer in Ethiopia, reported differential effects of farm size. Farm size affected the three technologies with differential impact, negative for single-ox technology and positive for pesticide, and fertilizer. ZELLER et al. (1998), in Malawi, found differential effects of farm size on adoption of improved and local maize and tobacco. Farm size, positively and significantly influenced the adoption of tobacco but did not affect the adoption of improved and local maize. BATZ (1999) in Kenya found both significant and non-significant effects of farm size on dairy production technologies. Positive and significant effect of farm size observed for cowshed and calf pen, while the effect was negative and significant for fencing technology. However, farm size had no exerted significant influence on the adoption of concentrate feeding and bucket feeding. SHIYANI et al. (2002), MUSSEI et al. (2001), LAPAR and PANDEY (1999), Mohamed (1996), and ADESINA and BAIDU-FORSON (1995), found no significance influence of farm size on the adoption of crop production in different area. Similarly, studies of dairy production technologies in Kenya did not influence of farm size (WAITHAKA, 1998).

Social participation

There is agreement among most research studies, that there is a relationship between social participation and adoption of innovations. ROGERS (1983) after Reviewing 149 studies stated, "Earlier adopters have more social participation than later adopters".

Thirty-five out of 59 studies found a significant positive relationship between the social participation and adoption (Table 1). Example of these study were, LAPAR and PANDEY

(1999), EL-GHAMRINI (1998), BALI (1996), SINGH et al. (1993), and SHAHIN (1995). While (24 out of 59) studies indicated no relationship between the social participation and adoption. Example of these study were, GETAHUN et al. (2000), MADHUKAR and RAM (1996), GOSWAMI et al. (2001), SINGH et al. (1993), and HOSSEIN (1998). In general social participation is a part of social communication network. It leads to better awareness and understanding of some new technologies and it may lead to adoption or rejection, of an innovation.

Cosmopoliteness

Contact with the world outside the village and especially urban centers links the farmer with the larger society, which has a positive influence on his level of consciousness and outlook. Most of research studies supported cosmopoliteness as a factor affecting adoption positively. ROGERS (1983) after reviewing 174 studies had generalized that: "Earlier adopters have a more favorable attitudes toward change than later adopters", since 76% of all the studies he reviewed supported such a generalization. A significant relationship between cosmopoliteness and adoption behaviour has been found in 44 out of 54 studies, which examined the relationship between two variables (Table 1). Example of these study were, GOSWAMI et al. (2001), ABD-ELLA et al. (1981), GOSWAMI et al. (2000), EL-ABASY (1995), AL-SAKRAN (2001), and EL-MEKAWY (1996). On the other hand, few studies (10 out of 54) reported no relationship between them. Example of these study were, SHIBAH et al. (2002), HOSSEIN (1998), GAD-AL-RAB and SHALABY (1997), and AHMED (1994).

Mass media exposure

There is agreement among most research studies, that there is a relationship between exposure to mass media and adoption of innovations. ROGERS (1983) after reviewing 116 studies stated "Earlier adopters have greater exposure to mass media communication channels than later adopters".

Eighty out of 116 studies found a significant positive relationship between exposure to mass media and adoption of innovations (Table 1). Example of these study were, BEMBRIDGE and TSHIKOLOMO (1998), GOSWAMI et al. (2001), GAD-AL-RAB (2000, ABD EL-RAZEK

(2002), and MADHUKAR and RAM (1996). On the other hand, few studies which found no significant relationship between them. These studies were, SINGH et al.(1993), AHMED (1994).

Extension contact

Majority of the research studies handling this factor reported a significant positive relationship between extension contact and adoption of innovations. Extension contact has a direct influence on adoption behaviour of farmers. ROGERS (1983) after reviewing 156 studies had generalized that "Earlier adopters have more change agent contact than later adopters", since 87% of all the studies he reviewed supported such a generalization.

Thirty-five out of 55 studies found a significant positive relationship between extension contact and adoption of innovations. Example of these study were, MUSSEI et al. (2001), GETAHUN et al. (2000), BAIDU-FORSON (1999), MADHUKAR and RAM (1996), and ABD EL-RAZEK (2002). While Twenty out of 55 studies found no relationship between the two variables. Example of these study were, BULALE (2000), SALAMA (2001), GETAHUN et al. (2000), MUSSEI et al. (2001), and ADESINA and BAIDU-FORSON (1995).

Contact with veterinarians

Contact with veterinarian has a positive influence on his level of consciousness of farmers. A positive relationship between veterinarian contact and adoption of innovations has been reported by all studies (Table 1). Example of these study were, SALAMA 2001, EL-MELEGI (2000), HAFZ and ANWAR (1999), BALI (1996), and HAFZ and ANWAR (1999).

Herd size

Majority of the research studies reviewed tackling the relationship between herd size and adoption, reported the existence of a significant relationship between these two variables. Thirty-two out of 45 studies found that there is a significant positive relationship between number of animals and the degree of agricultural innovations adoption (Table 1). Example of these study were, FOLTZ and CHANG (2002), MUSSEI et al. (2001), GETAHUN et al. (2000), MADHUKAR and RAM (1996) JABBAR et al. (1998), and SALAMA (2001). Only one study by EL-GANNAM (2000) indicated a significant negative relationship between two variables.

While twelve studies found no relationship between them. Example of these study were, SINGH et al. (1993), KEBEDE et al. (1990), GAD-AL-RAB and SHALABY (1997), and EL-HABAL and OSMAN (1989).

Farm income

Income is the most important indicator of the economic status of a farmer. It is, however, difficult to collect reliable information on income from farmers. This is one of the reasons why fewer studies attempted to relate income to the adoption behaviour farmers. Majority of these studies, which examined the relationship between the two variables, found income to be positively related with the adoption of agricultural innovations. Thirty-one out of 40 studies reported a significant positive relationship between the two variables. Example of these study were, ABD EL-RAZEK (2002), MUSSEI et al. (2001), GETAHUN et al. (2000), NEGATU and PARIKH (1999), BEMBRIDGE and TSHIKOLOMO (1998) and AYUK (1997). On other hand few studies (9 out of 40) stated no relationship between the two variables. Example of these study were, AL-SAKRAN (2001), EL-GANNAM (2000), MADHUKAR and RAM (1996), and SINGH et al. (1993).

Wealth index

Wealth index is a commonly used indicator of farmers' economic resources. Twenty-four out of 28 studies found a significant positive relationship between the wealth index and adoption of agricultural innovations (Table 1). Example of these study were, MIZHER (2002), SALAMA (2001), SAKR (2001), SOMA and BALI (1999), and EL-TANTAWY (1998). One study by ABOU EL-SHAHAT (1990) indicated a significant negative relationship between the two variables. While only three studies found no relationship between them. These studies were, AHMED (1994), SHIBAH and ABDEL-RAHMAN (1990), and YOSSEF (1981).

Labour

Some innovations could be labour saving while others are labour demanding. Instance cultivation with oxen is a labour technology and its adoption might be encouraged by labour scarcity, on other hand improved varieties generally require more inputs, so labour shortages may discourage adoption. Furthermore, new technologies may increase seasonal demand of labour, and their

adoptions are, therefore, less those with limited family labour (FEDER et al., 1985). The majority of studies (20 out of 27) found no relationship between labor and the adoption behaviour of farmers (Table 19). Few studies reported a significant positive relationship between the two variables. While only two studies reported a significant negative relationship between them.

MUSSEI et al. (2001), GETAHUN et al. (2000), and AL-SAKRAN (2001) found no relationship between labor and the adoption rates. However reports on the adoption of single-ox, pesticide and fertilizer technologies, showed mixed effects of family size on adoption rates. Family size significantly influenced the adoption of pesticide but had no influence on single-ox and fertilizer technologies (KEBEDE et al., 1990). SHIBAH et al. (2002) in Saudi Arabia found a positive relationship between labour and adoption of modern irrigation. In more recent study on the adoption of improved dairy production technologies in Kenya, family labour showed no significant effect (WAITHAKA, 1998). However BATZ (1999) found negative and significant effect of household size variable for labour availability on bucket feeding. The author also found significant and positive relationship between household size and dipping and spraying animals. Studies by EL-MAGHAWRY (1994), and YASSA (1983) reported a significant negative relationship between labour and adoption rates.

Credit

Farmers who have access to credit can relax their financial constraints and therefore buy inputs .It is expected that access to credit will increase the probability of adopting technologies. MUSSEI et al. (2001) in Tanzania, found all non-adopters 95% of adopters had difficult obtaining credit. The main constraints unavailability, lack of information and complicated bureaucratic are the major causes of the lower adoption rates observed for maize production. Few studies attempted to relate credit to the adoption behaviour farmers (Table 19). The majority of studies (9 out of 12) reported no relationship between the credit and adoption of technologies. Examples of these studies were GETAHUN et al. (2000), and JABBAR et al. (1998). BULALE (2000) found the effect of credit, measured as a credit provided for households, was exclusively used for crop production inputs (mainly for fertilisers), and hence had no significant influence on the adoption of all dairy production technologies studied. FREEMAN et al. (1996) observed the influence of credit on farmers' investment and production decisions among smallholder dairy producers in Ethiopia. Two studies by, and JABBAR et al. (1998) found positive relationship between the two variables.

Additional occupation

Most of the studies reported no relationship between additional occupation besides agriculture and adoption of agricultural innovations. Twelve out of fourteen studies no relationship between additional occupation and adoption of agricultural innovations. Example of these study were, MUSSEI et al. (2001), BULALE (2000), GETAHUN et al. (2000), and JABBAR et al. (1998). Two studies by MOHAMED (1996), and ABOUL-EZ (1985) found a positive relationship between the two variables.

2.6 Influence of technology characteristics on the rate and speed of adoption.

A review of literature (BATZ et al., 2003) shows (Table 2) that the empirical knowledge on influence of technology characteristics on adoption is poor and the results of existing studies only provide limited information that is inadequate for forecasting and adoption (FEDER et al., 1985).

Only few studies discussed the influence of technology characteristics on rate and speed of adoption of livestock technologies. Most of these studies related to industrialized countries. Moreover, large studies are not available in official journals and difficult to access. Only three studies could be found that, dealt explicitly with the influence of technology characteristics on the speed of adoption. These studies were FLIEGEL and KIVLIN (1966), FLIEGEL et al. (1968), and BATZ et al. (2003), which investigated these parameters in the Pennsylvania dairy sector, in the Indian Punjab and Kenyan dairy sector.

Economic return

FLIEGEL and KIVLIN (1966) found that the pay-off, defined as the "magnitude of financial rewards", was an important criterion for farmers' adoption decision. FLIEGEL et al (1968), who compared medium -scale and small- scale Pennsylvania dairy farmers with Punjab small- scale farmers, found that the pay-off of the technologies significant influenced the rate of adoption by small –scale Pennsylvania dairy farmers. But the pay-off was not related to the adoption behaviour of medium –scale of the Pennsylvania dairy farmers and the Punjab farmers. Studies by FLIEGEL and KIVLIN (1966) and FLIEGEL et al (1968), reported that the rate of costs recovery was not significant in any of the three samples.

Table 2. Studies dealing with speed of adoption in the livestock sector

Technology characteristics	Results of Fliegel and Kivlin (1966)	Results of Fliegel et al (1968)	Results of Batz et al. (2003)
Economic return			
Pay off	Pennsylvania (+)	Pennsylvania (MS) (ns) Pennsylvania (SS) (+) Punjab (ns)	
Cost recovery	Pennsylvania (ns)	Pennsylvania (MS) (ns) Pennsylvania (SS) (ns) Punjab (ns)	
Costs			
Initial cost	Pennsylvania (+)	Pennsylvania (MS) (+) Pennsylvania (SS) (ns) Punjab (ns)	
Continuing cost	Pennsylvania (ns)	Pennsylvania (MS) (ns) Pennsylvania (SS) (ns) Punjab (+)	
Risk	Pennsylvania (-)	Pennsylvania (MS) (-) Pennsylvania (SS (-) Punjab (ns)	Kenya (-)
Complexity	Pennsylvania (ns)	Pennsylvania (MS) (ns) Pennsylvania (SS (ns) Punjab (ns)	Kenya (-)
Investment			Kenya (-)

(ns)= not significant ; + = significant positive relationship ; - = significant negative relationship ; ( ) = results from different site ; MS =Medium scale ; SS = small –scale ; Source : Complicated by Batz et al. (2003).

Costs

In the case of initial costs, the partial correlation coefficient was even positively correlated with adoption. The study of FLIEGEL et al. (1968) indicated that the influence that the cost attributes of technologies differed according to farm size-class. High initial cost had a positive effect by medium –scale farmers. The risk characteristics of technologies studied the studies by FLIEGEL and KIVLIN (1966), FLIEGEL et al (1968), and BATZ et al. (2003) seems to be a significantly negatively correlated with the adoption in the two Pennsylvanian samples of both studies and Kenyan farmers. While among the Punjab farmers were not affects of risk characteristics on adoption (FLIEGEL et al., 1968).

Complexity

FLIEGEL and KVLIN (1966) reported no relationship between complexity and adoption in the all sites. In contrast, the study by BATZ et al. (2003), found a significant negative relationship between complexity and adoption.

Investment

BATZ et al. (2003) found negative relationship between investment and adoption between Kenyan dairy farmers.

On other hand the results of studies in other sector was presented in Table 3. Examples of the importance of the profitability of adoption decision by farmers are summarized in studies from Mexico (BYERLEE and POLANCO,1986), Australian (CARY and WILKINSON, 1997), Egypt (EL-GHAMRINI, 1998), and USA (EL-GHAMRINI et al., 1995). These studies dealt with different technologies, they all found that profitability affected positively on adoption decisions.

Table 3. Studies dealing with the speed of adoption outside the livestock sector

Authors	Country	Technology	Effect
Profitability			
ElGhamrini1998	Egypt	Aquaculture	+
Abo- Halima 1986	Egypt	Tomato	+
Shalabi 1988	Egypt	Rice	+
Byerlee and Polanco (1986)	Mexico	Variety, Weed control, Fertilizer	+
Raj and Knight (1977)	Mexico	Variety, soil	+,+,+
Byerlee and Polanco (1982)	Mexico	Tractor, combine, harvester, drill, seed, fertilizer, pesticides	+
Cary and Wilkinson (1997)	Australian	Soil conservation	+
Zahran 1987	Egypt	Fish	+
Dahab 1986	Egypt	Soybean	+
El-Ghamrini et al. (1995)	USA	Telecommunications	+
Costs			
Aly 1995	Egypt	Variety	-
Adesina and Zinnah (1993)	Sierra lone	Rice seed	-
Cary and Wilkinson (1997)	Australian	Herbicides	ns
Raj and Knight (1977)	Mexico	Variety, soil	-,-,ns
Complexity			
Aly 1995	Egypt	Variety	+
Cary and Wilkinson (1997)	Australian	Soil conservation	+
Zahran 1987	Egypt	Fish	+
Raj and Knight (1977)	Mexico	Soil, Variety	-,-,-

ns= not significant; + = significant positive relationship; - = significant negative relationship
( ) = results from different site; Source :own complication

Studies from Sierra Leone (ADESINA and ZINNAH, 1993), Mexico (RAJ and KNIGHT, 1977), Australian (CARY and WILKINSON, 1997), and Egypt (ALY, 1995) investigated the influence of cost characteristics on adoption. Most of these results stated a significant negative relationship between the two variables. Studies dealing with complexity showed that a low degree of complexity had a positive influence on the adoption.

3 Agricultural production, research and extension in Egypt

3.1 Introduction

Egypt is a large arid, and lowland country on the northeast Africa. Egypt's land area is 1 million Km^2. The populations live near the banks of the Nile and in the Delta. The climate of Egypt is governed by its location in the northeastern part of Africa to the margin of the largest desert in the world. Its latitudinal position, between 22 and 32 N places it firmly in the sub-tropical dry belt.

Given its latitudinal position it is not surprising that over much of Egypt mean annual temperatures are ranging between 20 and 25 ^{o}C. Major variations occur between summer and winter temperatures, as well as between coastal and interior locations. In the Delta the climate is Mediterranean with hot rainless summer (mid-March to mid-October) and mild, frost- free winter with some rain. Mean maximum and minimum annual temperatures are ranging between 28 and 14 ^{o}C, respectively. Summer maximum temperatures are ranging between 32-35 ^{o}C with 20 ^{o}C minimum. Mean winter temperatures show a maximum of 20 ^{o}C and minimum of 7 ^{o}C.

Egyptian agriculture is one of the oldest agricultural production systems in the world. It is undergoing the most significant changes in decades. Traditionally, government intervention has been a distinctive feature of Egyptian agriculture and, for the past thirty years, a policy of tight centralized control over the whole agricultural production and food distribution processes has been in place.

The period since late 1980s is characterized by stagnating agricultural development, declining food self-sufficiency and massive food import bill, worsening economic conditions, and continual pressure from international lending institutions. The Egyptian government has begun to implement a major agricultural reform programme, that phases out rigid crop procurement and agricultural input polices and has liberalized the agricultural sector creating a more favorable environment for Egyptian farmers. However, Egypt's large and rapidly increasing population, in excess of fifty–nine million in the last census 1996 (CAMPS, 1997). The shortage of cultivatable land, and agriculture's dependence on irrigation water, primarily from the Nile, are major constraints the task of increasing agricultural production and food self –sufficiency. Modern agricultural development in Egypt started early in the 19th century. At that time the population of the country was only 2.5 million. The cultivated area was about 2.5 million feddan (one

feddan=0.47 hectare) and the cropping intensity was less than 100% (i.e. land was cultivated with less than one crop per year)(NBE, 1998).

By the beginning of the 20th and owning the construction of the delta barrages, the cultivated area was raised by 0.5 million Fadden and the cropping intensity was raised to 150%. However, the population was also increased to 10 million.

As of today, the Egyptian population is estimated at 63 million (25 times as much as the population 200 years ago), the cultivated area is about 8 million Fadden and the cropping intensity is about 200% (EL-QUOSY, 2001).

Egyptian agricultural is unique. Egypt possesses three great natural recourses: Land, climate, and water. Almost all of the soils are very good quality without serious limitation in use. Probably no country has a better agricultural climate than Egypt (SAMY, 1988). As far as agriculture is concerned the critical climatic factors are those occurring during the growing cycle of the crops. What happens at other times of year is relatively unimportant. Given the stable temperatures throughout the year and the perennial irrigation system, Egypt has been able to develop a cropping pattern, which has permitted the cultivation of both winter and summer crops. Traditionally, before the advent of perennial irrigation in the nineteenth century, the Nile Valley was characterized by winter crops, of which the most important was wheat. With the development of summer cultivation, crops such as cotton, rice, sugarcane, and millet became important (BEAUMONT and MCLACHLAN, 1985).

The most widely winter crop is wheat, which is cultivated along the whole length of the Nile Valley. Winter crops cover the season from November to May, the major crops being Egyptian clover, wheat, broad beans and vegetables; summer crops include cotton, rice, maize, and vegetables and are grown between May and October.

According to the last agricultural census in 1996, farm holdings in Egypt are classified in three types of tenure: owned, rented, and owned/rented, with 5.09 Million Feddan owned, 0.677 Million feddan rented, and 1.5 Million feddan owned and rented. The main and almost source of surface water is the River Nile. Using Nile water for irrigation, there are 6.3 Million feddan, which account for 87% of the total area in Egypt (MALR, 1998, BISWAS, 1999).

3.2 Agricultural production

The agricultural production comprises three activities, crop production, animal production, and fish production. The agricultural sector in Egypt account for about 20% of both the GDP and total exports, and about 34% of the employment in 1999. Crop production contributes 63.9%, animal production contributes 30.0% and Fish production in Egypt contributes 6.1% to the total agricultural production in Egypt (AGRICULTURAL STATISTICS, 2001).

3.2.1 Farming systems

3.2.1.1 Animal production sector

Agricultural production is dominated by peasant agriculture in which livestock are often kept for multiple functions. PETERS (1999) summarized the multiple functions of animal husbandry into the following categories: Food production function, insurance, capital accumulation and income generating functions and internal integration function. Among output uses are subsistence consumption, direct supply of farm inputs, cash through sale of live animals or their outputs, savings and investment through increasing size and quality of herds and social functions such as holding wealth (PETERS, 1995).

In Egypt the average annual number of cows and buffaloes and goats reached about 3.53, 3.38, 3.42 million head, respectively, for the period (1999-2001). These averages represented about 0.24%, 1.98%, and 0.46% to the total annual average of cows and buffaloes and goats in the world, respectively, in the same period. According to the published statistics of (FAO, 2002). Cattle and buffaloes and goats in Egypt and in the world are summarized in (Table 4).

Table 4. Number of cows, buffaloes and goats in both Egypt and world (1000) Head

Item	Country	1999	2000	2001	Average (99-2001)	% World
Cattle	Egypt	3418	3530	3636	3528	0.26
	World	1332249	1346430	1351792	1343490	100
Buffaloes	Egypt	3330	3379	3430	3380	2.06
	World	162067	164446	165724	164079	100
Goats	Egypt	3308	3425	3527	3420	0.47
	World	713145	725470	738246	725620	100

Source: Collected and estimated from: FAO, Statistics yearbook, Rome, Italy (2), (2002).

In Egypt animal production contributes about 30.02% to the total value of agricultural production. The red meat production takes the first rank among the animal production followed by milk, poultry, meat, eggs, wool, honey and bees wax, and silk production. The percentages were 41.07%, 26.02%, 16.03%, 4.64%, 0.47%, 0.42%, and 0.001%, respectively.

The manure accounts for about 11.35% of the value of total animal production of Egypt. The population of dairy animals is about 6.9 million heads of cattle and buffaloes. From the published data of MALR 2001,cattle and buffalo populations for all Egypt are summarized in the Table 5.

Table 5. Cattle and buffalo population in Egypt

Item	Number (million)	%
Cattle	3.528	51.10
Buffaloes	3.380	48.90
Total	6.900	100.00

Source: Animal production Sector Statistics, MALR 2001.

According to published statistics of the MALR (2001), and to study of economics of milk in Egypt, the total milk production from cattle and buffaloes is about 3.7 million tons (Table 6). About 55%of the total milk output comes from buffaloes.

Table 6. Milk production from cattle and buffaloes

Item	Milk production (Million tons)	% Of the total milk production
Cattle	1.64	44.0
Buffaloes	2.08	56.0
Total	3.72	100.00

Source: Animal production Sector Statistics, MALR 2001.

3.2.1.2 Importance of buffaloes

In Egypt, buffalo milk account for at least 56% of the total milk production, and buffaloes beef and veal account for more than 41% of total red meat production. The greatest asset of the buffaloes as a domestic animal is its ability to subsist on the coarsest fodder and convert it most efficiently into milk with remarkably high butter fat content and meat of exceptional leanness. An average increase in live weight of 0.90 kg per day has been recorded but the dressing percentage is always lower than that of cattle (FOODA, 1996;Abdel-Aziz and SADEK, 2000).

Buffaloes are considered rather tolerant to diseases. Buffalo milk is preferred by Egyptian consumers because of white color and high fat content (7%) (OSMAN, 1997).

3.2.1.3 Dairy farming systems.

Crop and livestock farming in Egypt were carried out independent of each other up to the beginning of the 19th century. Since then ,state policy has encouraged small farmers to set up mixed livestock /crop enterprises with a view to promoting cotton production. Livestock provided draught power needed to expand the cultivated area. Over the years, livestock farming has acquired additional roles including the restoration of soil fertility and provision of farm income (RUF, 1986). There are two major milk production systems in Egypt:

The first system is the mixed crop/livestock system, which is traditionally integrated with the dominating agricultural system. It contains about 96% of the cattle and buffalo population and produces about 70% of the total domestic milk output. This system is characterized by:

- Smallholdings of herds (1-5 heads/farm) of low producing native animals.
- No records for milk or for any other activities.
- Low values of inputs and outputs.
- Surplus milk is sold at farm gate to middlemen at low price, live animal are sold alive in village markets.
- Most services have been provided to the farmer by the MALR free of charge, but currently a cost recovery basis has been applied to some service.
- The farmer families are the primary consumer of the milk, and, therefore, the contribution of this system to the regular milk market does not match its share.

The second system is the (intensive) industrial production system, which contains large commercial farms of more than 50 heads mainly of high- yielding foreign breeds of cattle. Commercial farms hold about 4% of the total cattle and buffalo population but produce about 30% of the marketed. Milk recording in most of these farms is conducted through computerized dairy management programs used mainly for controlling and operating farm activities and supporting decision-making. Large-scale farms belong either to specialized companies, cooperatives or are privately owned. Some large companies have their own dairy processing plants and feed meals. Most large dairy farmers are members of the General Cooperative for the Development of Animal Wealth located in Cairo or other associations such as those of the Egyptian Buffalo Producers' Association (EBPA) or Egyptian Milk Producers' Association (EMPA)(SADIK, 2002).

3.3 Research and extension systems

3.3.1 Ministry of Agriculture Framework in Egypt

The Ministry of agriculture is the principal institution setting agricultural policy and planning and carrying out agricultural development programs to assist farmers in producing enough food for the country. Under the administrative authority of the ministry of agriculture, the agricultural research center and the agricultural service, which takes the major responsibility for developing new technologies and transferring this technology to farmers. However, the impact of both organizations on technological progress in recent years dos not appear to be substantial. The Ministry of Agriculture in Egypt consists of the following sectors:

- The Principal Bank for Development land Agricultural Credit (PBDLAC).
- Agricultural Research Center (ARC).
- General Authority for Developing the High Dam Lake (GADHDL).
- General Authority for Developing Fish Wealth (GADFW).
- General Authority for Agrarian Reform (GAAR).
- General Organization for Veterinary Services (GOVS) and Livestock Insurance Fund.
- Executive Apparatus for Soil Amelioration Projects.
- General Authority for the Stabilization Fund of the Agricultural Crops.
- Cotton Improvement Fund.
- General Authority for Reconstruction and Agricultural Development Projects.
- Egyptian Agricultural Organization.
- Agricultural and Reclamation Land Fund.
- Desert Research Center.

3.3.2 Agricultural Research Systems

Significant national research into food and agricultural production is being conducted throughout the country and financed from many resources. Much of this research work is part of a carefully planned and well-coordinated effort reflecting national goals and needs. The organizational research chart of Egypt has different consequential systems:

- The Agricultural Research Center (ARC) is the primary agency responsible for technology generation in the Ministry of Agricultural and Land Reclamation (MALR).

- The Desert Research Center (DRC) is also under MALR, having five research stations, and is responsible for conducting research relevant to rainfed areas.
- National Water Research Center (NWRC) is within the Ministry of Public Work and Water Resources (MPWWR), having 12 institutes and a training center. It has the responsibility of conducting research in water resources, irrigation and drainage aspects related to agriculture, in addition to specialized activities related to construction, sediments, surveying and coastal.
- The National Research Center (NRC) is also involved in agricultural research through its irrigation, food, and agriculture division.
- The National Center for Radioactive Research.
- The private sector, which is increasingly getting involved in agricultural research, particularly in the area of seed production, tissue culture and micro-propagation, and agrochemical. However, ARC is the most productive research organization in Egypt with a numerous capacity to do excellent agricultural research that is greatly enhancing the agricultural development and increasing productivity.

3.3.2.1 Agricultural Research Center

The Agricultural Research Center (ARC) is a semi-autonomous organization, operating on a nationwide scope. The Minister of Agriculture serves as the chairmen of a board, but the director serves as the executive officer in charge of day–to-day operations. The director has two deputies. The first deputy is responsible for general services and administration; the second deputy is responsible for research activities. Since its establishment in 1930, the stated goal of the Research Center has been to conduct research for development of improved technology to increase agricultural production and to solve farmers` problems. The Agricultural Research Center (ARC) includes 16 research institutes, and 7 central laboratories located in Cairo. These research institutes are:

- Cotton production,
- Field Crop
- Plant Pathology
- Animal Production
- Horticultural
- Agric. Extension and Rural Development
- Soil and Water
- Sugar
- Plant Protection
- Animal Health
- Agricultural Economics
- Agricultural Mechanization

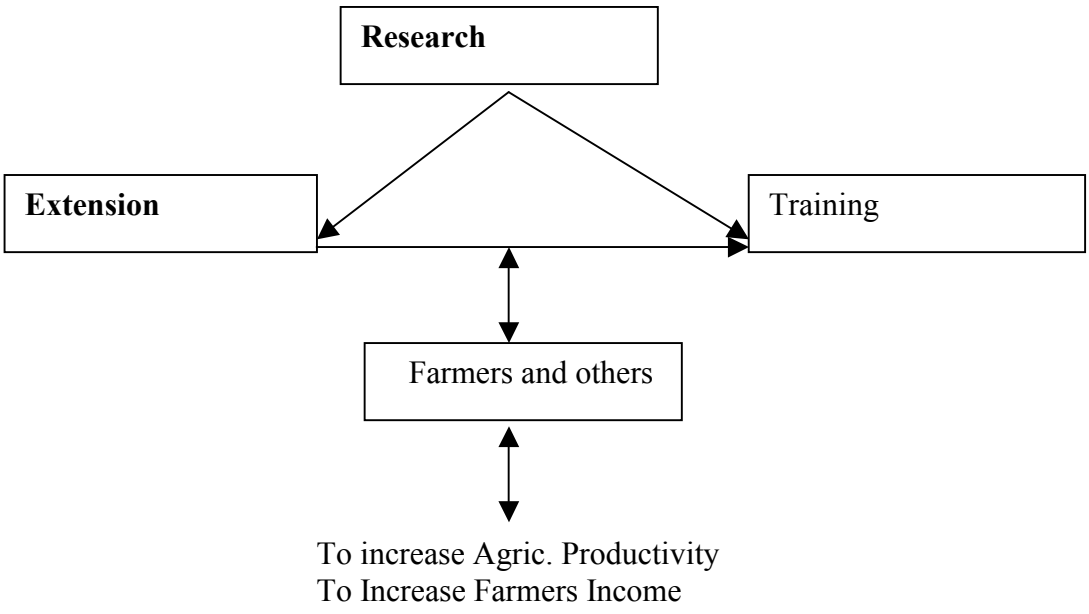
- Flora
- Fish and Aquaculture
- Food and Feed Technology
- Desert

ARC includes also four regional councils for research and extension, ten regional research and extension stations, and 37 commodity-oriented research and extension stations located throughout Egypt. Nineteen of these stations are bound for field crop commodities as well as their related supported disciplines. Six horticultural and 12 animal research stations are also in duty. Moreover, there are 21 agricultural experimental units scattered throughout the different governments for on-farm research verification at farmer's fields. The Research Center has overall administrative responsibility for the sixteen institutes including personnel, policies, budget, and program coordination. The budget of the Agricultural Research Center for the fiscal year 1997/98-2001/02 was 412 million L.E. (MINISTRY Of PLANNING, 1997/98-2001/02).

3.3.2.2 ARC Activities

ARC policy framework is built on an active communication among three major components; research, extension, and training (Figure 4).

Figure 4. Research –Extension and farmer linkages



Source: General administration of Agricultural Extension in Cairo Egypt (2002).

- **Research Activities**

The frame work of the ARC realizing the technological advance needed for agricultural development in Egypt is being governed by 18 national programs which cover more than 50 sub-programs: Fiber crops, cereal crops, oil crops, legumes, forages, sugar crops, fruits, vegetables and ornamentals, animal and poultry production and health, soil and water, agricultural mechanization, plant protection, food and feed technology, socioeconomic and statistical research, expert systems, extension and rural development, genetic engineering and aquaculture.

- **Extension Activities**

The main objectives involve the development of agricultural extension programs that are timely and meet the needs of a growing Egypt amidst a changing global environment. A major focus of the extension programs deals with decentralizing planning and implementation of extension programs for rural development of field crops, horticulture, and the production of animals, poultry and fish in order to make local programs more accessible and meaningful to farmers. Another aspect of the extension program focus is to recognize and quantify the social changes that occur in rural areas as a result of agricultural sector development. The technology transfer program is built on good communication among researchers, extension agents, and farmers. To accomplish this ultimate goal, several extension teaching methods have been used by researchers and extension workers to accelerate the transfer of new agricultural technologies to farmers (MANSOUR and ELSHAHED, 2001).

- **Training Activities**

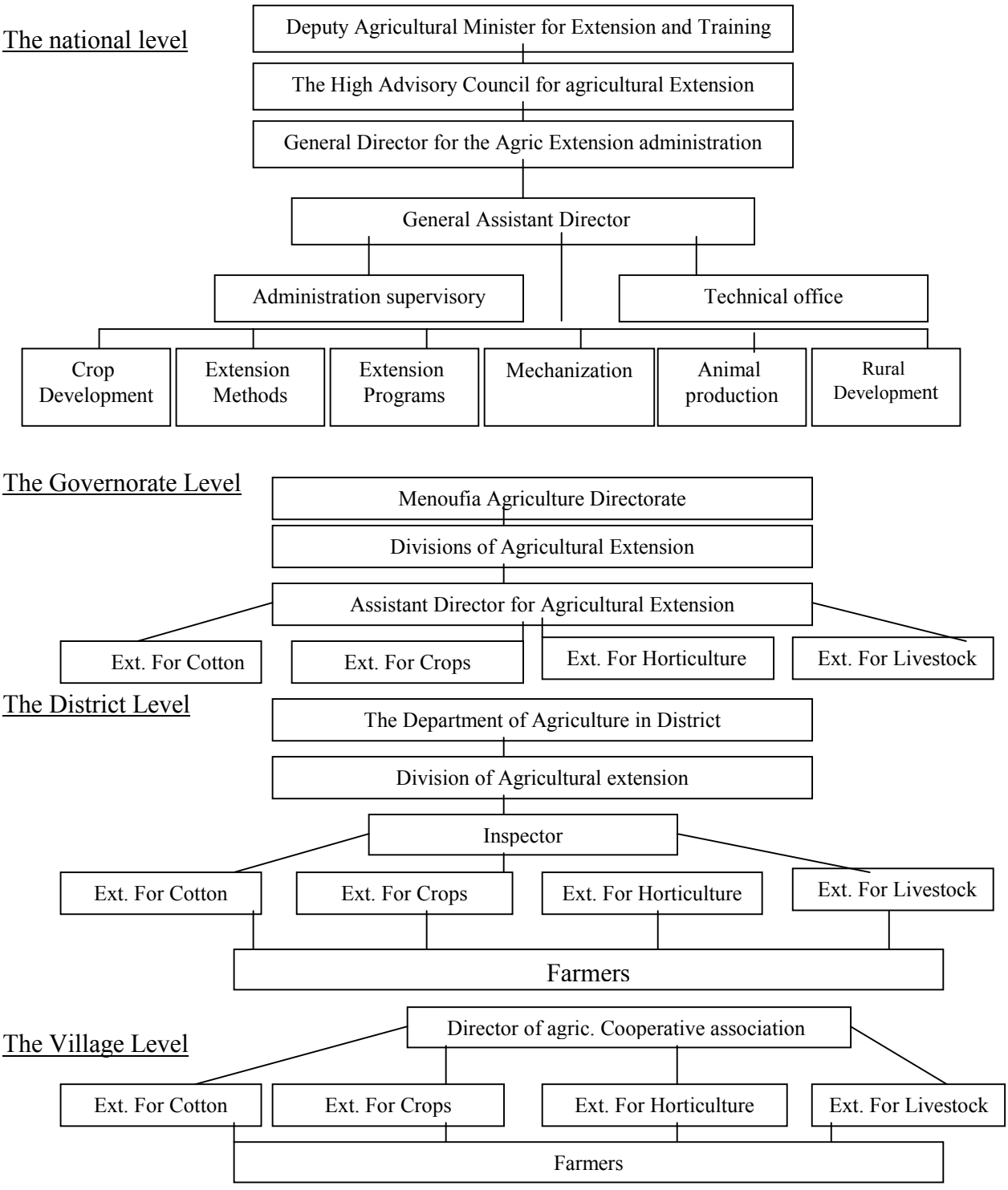
During the last decade training has played an effective role to strengthen agricultural technology in Egypt. Actively in-country training programs of both research and support staff within-ARC as well as others out-of ARC has taken top priorities. Out of country training can take the form of graduate studies, postgraduate, and short training courses.

3.3.2.3 Agriculture Extension Service in Egypt

Ministry –Based general extension. Shortly before or after independence, organizing agricultural extension work under the wings of the ministry of agriculture seemed to be an ideal solution for many African and Asian government (Nagel, 1997).

Figure 5 shows the organization of state agricultural extension in relation to the study area. The extension service is designated to be the government arm for diffusing new agricultural technology to farmers.

Figure 5. The organization of state agricultural extension in relation to the study area



Source: General Administration of Agricultural Extension in Cairo Egypt (2002).
General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

Since its establishment in 1953, the extension service has stated its goal to be that of carrying research results, in the form of recommendations, to farmers, thereby increasing agricultural production, and in turn, achieving higher standards of living in the rural areas. Currently, a countrywide network of extension units is developed to provide extension services to every village. The Extension Service Headquarters in Cairo includes six divisions, and technical office. These divisions are: Crop Development, Extension Methods, Extension Programs, Mechanization, Animal Production, and Rural Development Divisions. In the extension service Headquarters the most extension programs are initiated and funds are allocated. The extension employees work at the local levels and fall under the administrative authority of the twenty-six governorates. In each Governorate extension is structures include the governorate, district, and village level. Each Governorate is responsible for planning and carrying out its own extension programs, however, these programs are reviewed and approved by the national extension service. The head of the extension department in each governorate reports to both the director of the national Extension Service and to the Undersecretary of Agricultural in his governorate. The extension service, at both the national and local levels, concentrates its efforts on two main types of activities: (a) Field demonstrations, and (b) Publications. Each year, the director of the Extension Service assigns each governorates` crop demonstration quota, and allocates funds for demonstration farmer incentives. Then, the heads of governorate extension department meet with the local staff at the district and village levels and assign area locations and funds for these field demonstrations.

3.4 Farming systems in Menoufia

3.4.1 Farm size Menoufia

According to the agriculture census 2002, farms in Menoufia are classified into three types of tenure: owned, rented and owned and rented. Table 7 shows the number of land holding and area according to tenure status. Landowners are estimated to be 180778 holders with an area of about 186573 Feddan. Farms with rented land are estimated to be 38857 holders with an area of about 39598 Feddan. Owned and rented farmland is estimated to held by 51107 holders with an area of about 69643 Feddan. The total number of farms is about 270742 holders with an area of about 295814 Feddan.

Table 7. Distribution of Farm Size per household (fed) in the different Districts of Menoufia

Districts	Owned			Rented			Owned + Rented		
	No	Area	Average	No	Area	Average	No	Area	Average
Shebeen El kom	21991	17136	1.28	4586	3766	1.22	5792	7091	0.82
Qussna	25588	35336	0.72	5826	5111	1.14	4936	7591	0.65
El-Bagour	24860	22594	1.1	2205	1763	1.25	3633	8809	0.41
Ashmoun	23350	26899	0.87	10262	10441	0.98	10671	16899	0.63
Menouf	23640	23816	0.99	4562	5576	0.82	8436	12472	0.68
El-shohada	11010	15177	0.73	5060	5260	0.96	10250	8195	1.25
Tala	30421	27214	1.12	2293	3726	0.62	2736	2011	1.36
Barkat El Sabah	16851	14443	1.17	2538	2077	1.22	3532	4319	0.82
El-Sadat	3067	3958	0.77	1525	1878	0.81	1121	2256	0.5
Total	180778	186573	0.97	38857	39598	0.98	51107	69643	0.73

General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

3.4.2 Irrigation in Menoufia

Irrigation water is brought to every village free of charge by the Ministry of public works and Water Resources. The flow of water into the canals is fixed according to the area served and official requirements for each region and cropping season as laid down by the Ministry of Agriculture. The size of each field outlet is supposed to be fixed for each farmer depending on the area of the property; it has been claimed. However, that farmer in many areas circumvents this retraction on the quantity of water reaching their land. Canals are normally cleaned out and maintained annually in January. Irrigation rotations are enforced by the alternating the water level in the canals to give wet and dry periods. The common patterns are:

- February – April: 5 days high level, 5 days low level, 5 dry;
- April – December: 7 days wet, 7 days dry;
- Rice and vegetable areas: 4 days wet, 4 days dry.

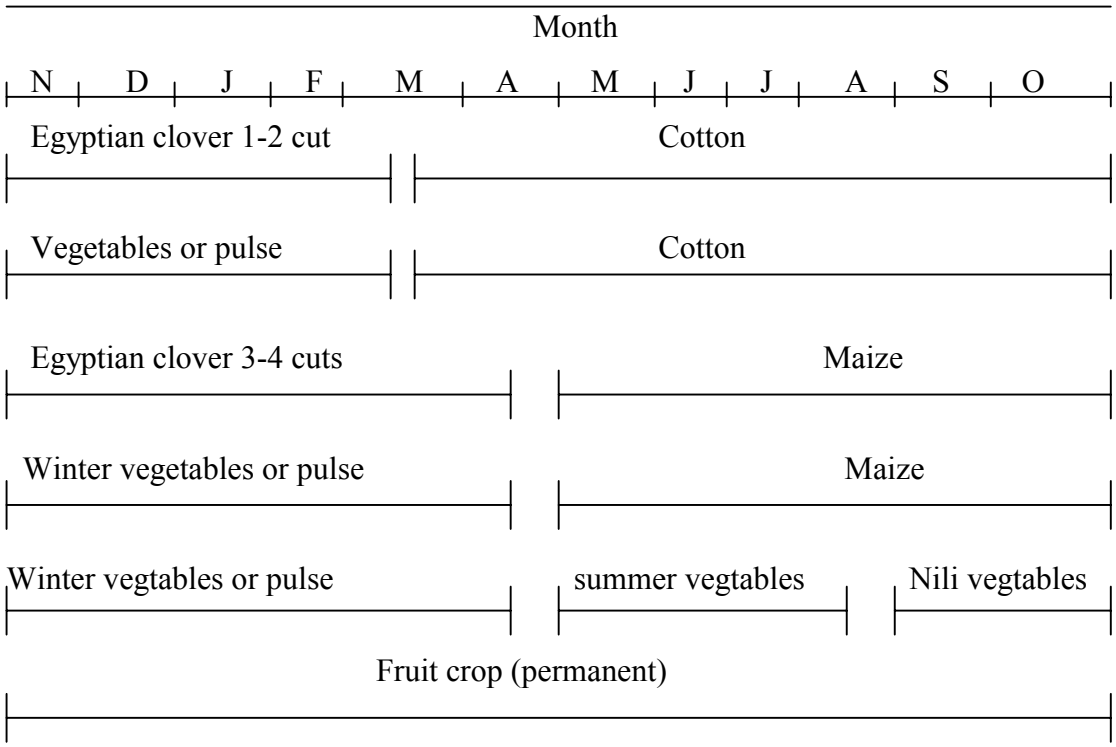
In most areas the farmer has to irrigate in his traditional manner, which is to over- irrigate and allow excess water to drain away. Water is normally available in sufficient quantity and free of charge, so there has been no incentive to modify this practice (MPWWR, 2002).

3.4.3 Cropping pattern in Menoufia

Knowledge of the main crop rotation patterns is essential as a base to the understanding of the agricultural system in the Menoufia. As irrigation water is available all the year round, continuous cropping is in practice, with an average of two crops per year.

The main crops rotation is summarized in (Figure 6), and the agricultural year is shown to commence in November with the sowing of the winter crops. The main field crops require 4 – 6 months to harvesting, whereas most vegetable crops require only 3-4 month.

Figure 6. Pattern of cropping used in the main rotations in the Menoufia.



Source: General administration of agriculture in Menoufia (2002).

There are various rotations but all use winter and summer crops with some Nili crops. Winter crops cover the season from November to May, the major crops being Egyptian clover, wheat, broad beans and vegetables; summer crops include cotton, maize and vegetables and are grown between May and October. Nili crops, which are, now of much less importance, were formerly the autumn-sown crops following the Nile floods; the term refers to autumn-sown vegetable and maize crop. The land is not fallowed, and the most common rotation is a three-years crop rotation, for example (Table 8).

Table 8. The three-year crops rotation in Menoufia

Year	Winter crop	Summer crop	Nili crop
1	Egyptian clover (1-2 cuts)	Cotton	-
2	Egyptian clover (3-4 cuts)	Maize	Vegetables
3	Wheat or barley	Maize	Potatoes

General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

Maize is the main cereal crop grown in the Menoufia in summer. Pulses can replace some of clover and wheat in winter. Near to the urban centers, vegetables are more common and can give four crops per year; intercropping is common. On more fertile soil, a two-year rotation is sometimes used for example:(Table 9).

Table 9. The two-year crops rotation in Menoufia

Year	Winter crop	Summer crop
1	Egyptian clover (1-2 cuts)	Cotton
2	Egyptian clover (3-4 cuts) or wheat	Maize

Source: General Administration of Agriculture in Menoufia (2002).

The crop percentages were calculated and tabulated in Table 10. Some 60 percent of Egypt's home-produced wheat is grown in the Delta (Menoufia), and the crop is grown following cotton, maize, or vegetable. An area of 86216 Feddan was grown in Menoufia in 2002. Maize is the main cereal crop grown in the Menoufia and is traditionally used by the rural population for bread making; it is also the only green fodder available in summer. The cultivated area of maize reached about 231115 Feddan in 2002.

The main potatoes-producing area is the Menoufia Governorate with sizeable quantities also grown in Beheira. It is the second most important vegetable crop after tomato and the most important vegetable export crop in Delta. An area of 10395 Fadden was grown in Menoufia. Although the cotton crop is now declining in importance, in the Delta especially in Menoufia it is still the most important crop and is a major export crop. An estimated 32113 Feddan is grown.

Table 10. Area of crop production per household (fed) in different Districts Menoufia

Districts	No. Of Holder	Wheat crop		Maize crop		Cotton crop		Potatoes crop	
		Area	Average	Area	Average	Area	Average	Area	Average
Shebeen El kom	32369	11200	0.35	25835	0.01	3741	0.01	188	0.01
Qussna	36350	10200	0.28	26326	0.01	6397	0.01	282	0.01
El-Bagour	30698	10300	0.34	21273	0.09	1597	0.09	2792	0.09
Ashmoun	44283	12200	0.28	51849	0.07	624	0.07	3210	0.07
Menouf	36638	12500	0.34	37033	0.06	2252	0.06	2114	0.06
El-shohada	26320	7600	0.29	20838	0.01	5502	0.01	291	0.01
Tala	35450	11216	0.32	25446	0.03	6710	0.03	1018	0.03
Barkat El Sabah	22921	8400	0.37	15134	0.02	5290	0.02	439	0.02
El-Sadat	5713	2600	0.46	7381	0.01	0	0.01	61	0.01
Total	270742	86216	0.32	231115	0.04	32113	0.04	10395	0.04

Source: General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

3.4.4 Importance of cattle and buffalo in Delta (Menoufia)

Animal production has been an integral part of the mixed farming system of Menoufia; animals were generally regarded as necessary accessories to crop production. More recently, however, animal production has begun to develop in its own right, specially the modern poultry industries and cattle and buffalo production. The distribution of cattle and buffaloes and average herd sizes in the different districts in Menoufia are shown in Table 11.

Table 11. Distribution of cattle and buffaloes by herd size in the districts in Menoufia

Districts	Number of holders	No. Of Animals			Average Herd Size per household		
		Buffaloes	Cattle	Total	Average buffaloes	Average Cattle	Total Average
Shebeen El kom	17831	35810	19858	55668	2.01	1.11	3.12
Qussna	9456	23542	11738	35280	2.49	1.24	3.73
El-Bagour	11048	38328	16507	54835	3.47	1.49	4.96
Ashmoun	34803	63798	39382	103180	1.83	1.13	2.96
Menouf	20650	49684	35277	84961	2.41	1.71	4.11
El-shohada	13002	22172	16320	38492	1.71	1.26	2.96
Tala	13072	26821	18229	45050	2.05	1.39	3.45
Barkat El Sabah	15770	19357	12249	31606	1.23	0.78	2.00
El-Sadat	2983	7278	9008	16286	2.44	3.02	5.46
Total	138615	286790	178568	465358	2.07	1.29	3.36

General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

In Menoufia, animal production is mainly in hands of small farmers. Cattle and buffaloes are the principal livestock in Menoufia. Buffalo serve as an economically important source of milk and meat and accounts for 70% and 40% of the total milk and meat produced in Menoufia. Buffalo is, therefore, considered as the main dairy animal in Menoufia. Buffalo calves with a birth weight of 40 Kg are usually sold off for deal (bitllo) after 40-60 days and at a live weight of a proximately 80 Kg (SHAZLY, 1985). The main reason is to save milk, but the farmer gets a good price due to the demand for veal. The meat of male buffaloes older than two year tends to be tough and adult male buffalo have a poor temperament. Cow calves are usually kept slightly longer because of their lower birth weights (24-27Kg) and slightly better growth rates.

Menoufia takes the third rank among public governorates in buffalo's milk production and the fourth rank in cow's milk production after Dakahlia, Sharkia, and Garbia governorates. The total number of buffalos reached 286790. The total milk production of Menoufia reached about 147552 tons in 1999 (Table 12).

Menoufia takes the first rank among public governorates in meat production in Egypt. The total meat production of Menoufia is 28859 Ton in 1999 (Table13) (MALR, 2000). The egg production reached 146 million eggs. The fish production and honey reached 15578 and 250 tons, respectively.

Table 12. Animal production in the Different Districts in Menoufia (Ton)

Districts	Red meat	White meat	Total meat	Milk	Fishes	Eggs	Honey
Shebeen El-kom	1288	2000	3288	18203	-	8	35
Ashmoun	2512	6125	8637	28347	-	10	22
El Bagour	1467	4339	5866	15492	-	22	17
El-Shohada	641	2958	3599	14666	-	4	13
Barkat El-Sabah	1120	2271	3391	11674	-	44	33
Tala	978	2582	3560	16892	-	17	31
Qussna	501	4782	5283	13733	-	40	64
Menouf	954	2334	3288	24844	15578	-	33
El-Sadat	351	1596	1947	3701	-	-	1
Total	9812	29047	38859	147552	15578	146	250

General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

3.4.5 Husbandry system

Livestock keeping is primarily carried out in the home compounds and in very small numbers; one or two buffaloes or cows per family (FAO, 1995). Severe weather conditions especially those in the summer season can deteriorate animal health and productivity unless suitable housing protection is available. Traditionally, buffalos are tied in the barn that is constructed from locally available materials. In small herds, the animals could be tied in a single row. Farmers also keep animals in corrals constructed near the farmers` house.

Cattle and buffaloes are kept in traditional manner. From November to May, they are fed on Egyptian clover. Animals are usually tethered at the side of the field, where they are fed clover, which has been cut and carried to the animals. They are taken back to the house at night. In summer, the animals might be left near the house all the day or they might be taken to the fields during the day as in winter. Cattle and buffalo are usually taken to be watered.

These livestock are under the care of women who feed, clean, milk them, and are responsible for the processing of their produce. Liquid milk is generally not consumed and most of the milk is turned into butter and cheese, as well as consumed unprocessed, and in most cases the produce is

consumed within the family, though some exchanged or sold to neighbors or in the village market every week.

3.4.6 Management of animal feeding

Cattle and buffalo are considered together because they are managed similarly by the farmer. Cattle and buffalo are kept in the traditional manner. From November to May, they are fed on Egyptian clover. Animals are usually tethered at the side of the field, where they are fed clover, which has been cut and carried to the animals, they are taken back to the house at night. Therefore, it is recommended to feed some concentrates and some roughage such as wheat straw, rice straw and corn stalks. Fatting animals are generally kept inside all the time. In summer, when most of the land is under crops, the animal has to survive on various crop- by –products, either from the farm or purchased locally (METRY, 1996). The clover or beseem is traditionally the mainstay of the crop rotation and the major feed crop for animal production. It is the most extensively grown of all the summer and winter crops in Menoufia. Clover planted from September to November as soon as the proceeding crop (usually cotton, or maize) is off the land. At least four cuts can be taken between sowing and the following May (full season clover). The cultivated area of clover over the full season reached 86216 Feddan in 2002. 85 % percent of the Menoufia cotton crop is sown after (short season) clover in March; this gives only one or two cuts. The area of clover over the short season in Menoufia reached 35788 Feddan. The area of clover production per household (fed) in different districts in Menoufia is shown in Table 13.

Table 13. Area of clover production per household (fed) in different districts in Menoufia

Districts	Number of Holder	Clover long Season	Average per Household	Clover Short Season	Average per Household
Shebeen El kom	32369	11200	0.35	5000	0.15
Qussna	36350	10200	0.28	6969	0.19
El-Bagour	30698	10300	0.34	2800	0.09
Ashmoun	44283	12200	0.28	328	0.01
Menouf	36638	12500	0.34	3401	0.09
El-shohada	26320	7600	0.29	6446	0.24
Tala	35450	11216	0.32	6000	0.17
Barkat El Sabah	22921	8400	0.37	4844	0.21
El-Sadat	5713	2600	0.46	0	0.00
Total	270742	86216	0.32	35788	0.13

General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

4. Material and Methods

In this chapter deals with the procedures, material and methods of the study are described. More especially this chapter includes description of the study sites, sampling procedures, identifying the case technologies and operational definitions of variables, data collection and analysis procedures.

4.1 Location of the Studied Area

Menoufia governorate is located in the middle of the Delta in between the two branches of the Nile Valley, Rashid (Western) and Domiatt (Eastern). Menoufia Governorate is surrounded by Garbia governorate in the North, Giza governorate in the South, Bahira governorate in the West and Kaliobia governorate in the East (Figure 7).

Shebeen El-kom is the capital of Menoufia. The total area is about 2544 km^2 According to the results of the last census in 1996, the total number of population inside Menoufia governorate reached 2760431 inhabitants. The population growth rate is given as 1.53% p.a. (ADMINISTRATION of STATISTICS-MENOUFIA, 1999). The climate is Mediterranean with hot rainless summers (mid-march to mid-October) and mild, frost-free winters with some rains. Mean annual maximum and minimum temperature are 28 0C and 14^0C, respectively.

The number of Extension workers in Menoufia reached about 1336 (Table 14).

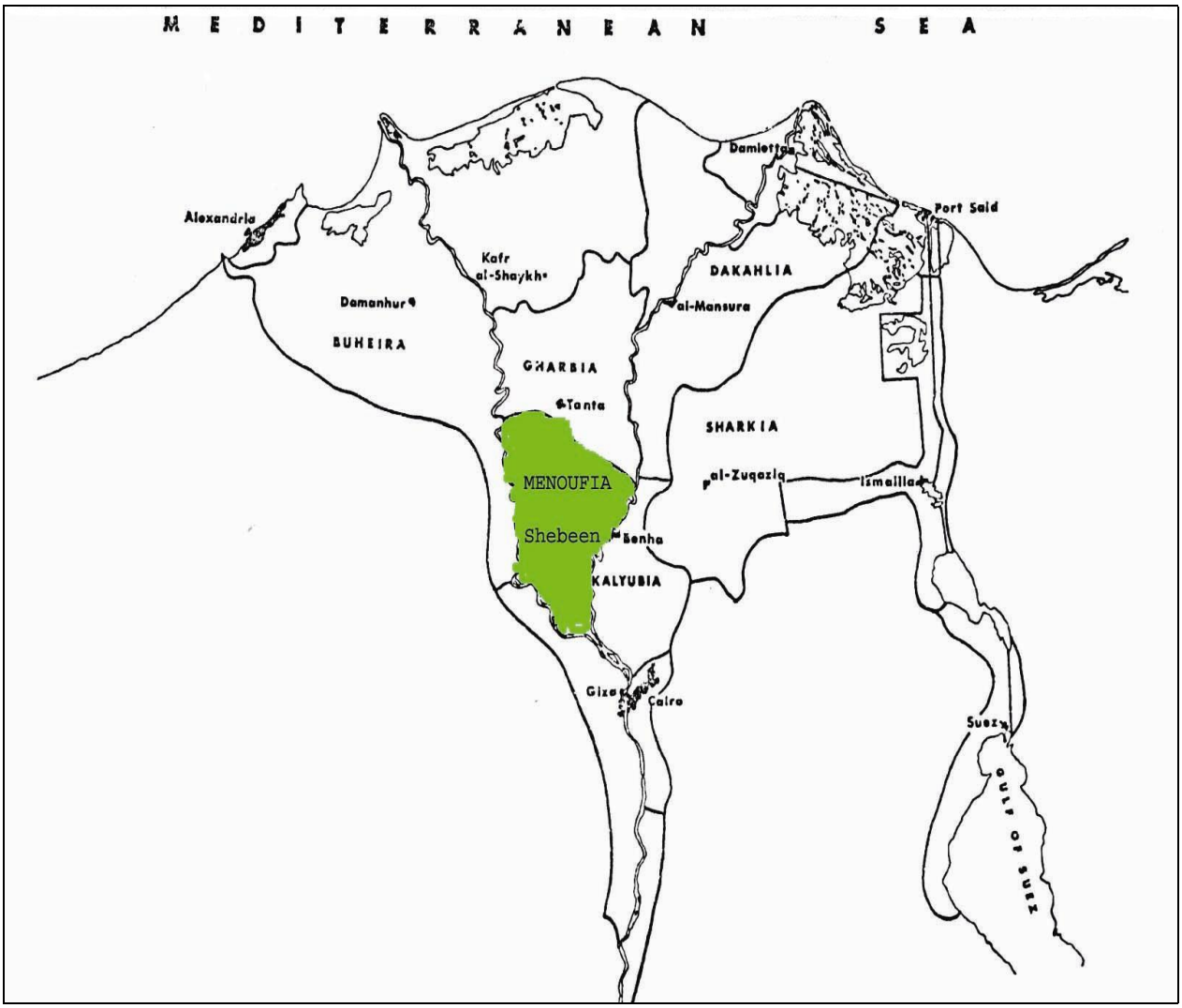
Table 14. The number of the extension worker in Menoufia Governorate

Distracts	Number of Extension workers	%
Shebeen El kom	144	10.78
Qussna	102	7.63
El-Bagour	155	11.60
Ashmoun	123	9.21
Menouf	230	17.22
El-shohada	131	9.81
Tala	270	20.21
Barkat El Sabah	146	10.93
El-Sadat	35	2.62
Total	1336	100.00

General administration of agriculture, Menoufia governorate, Egypt (2002).

Governorate is responsible for planning and carrying out its own extension programs, however, these programs are reviewed and approved by the national extension service. The head of the extension department in the Governorate reports to both the director of the national Extension Service and to the Undersecretary of Agricultural in his Governorate.

Figure 7. Map Lower Egypt



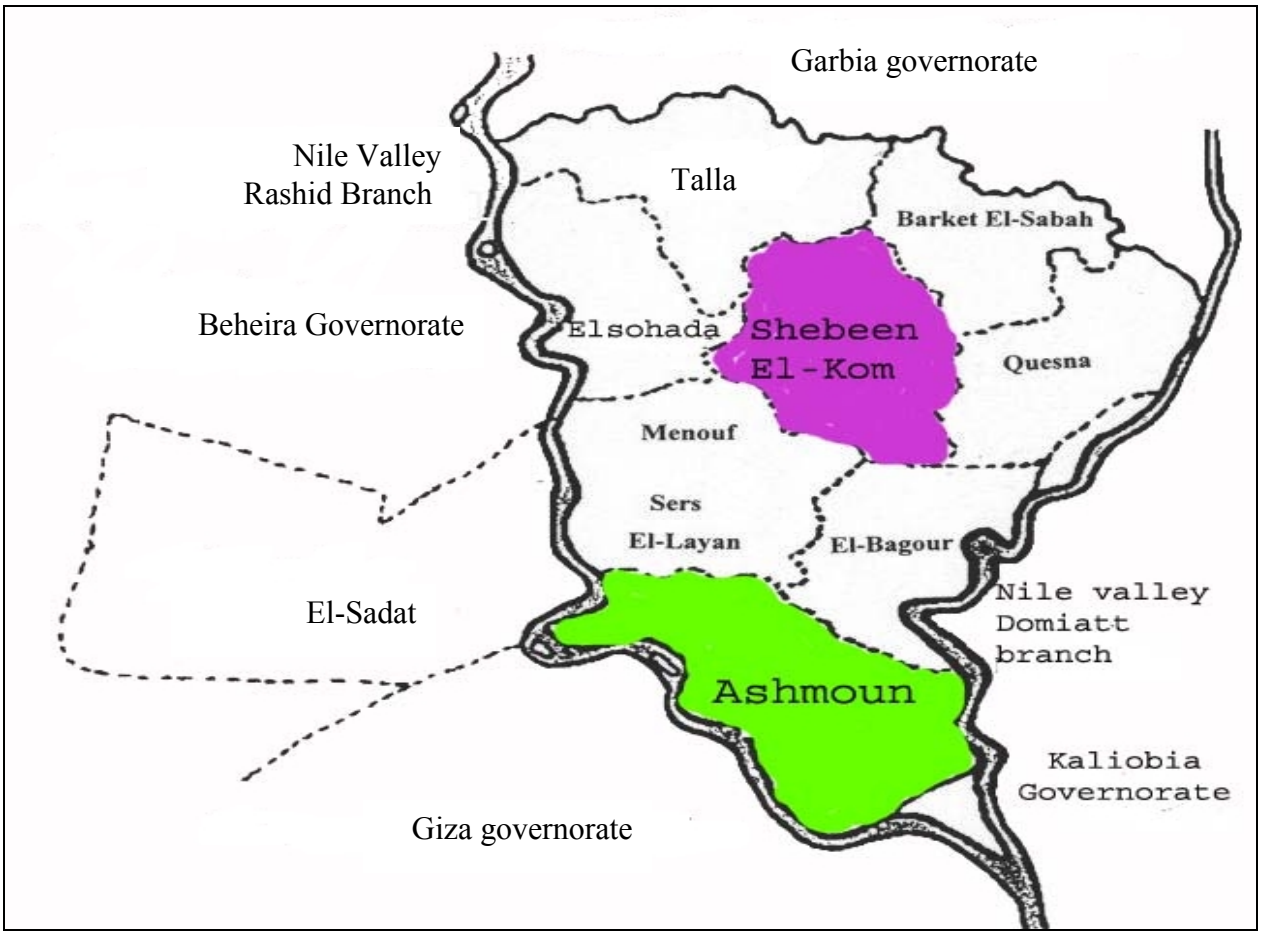
Source: Central Agency of Mobilization and Public Statistics (CAMPS) (1998).

4.2 The study sites

Study sites are Ashmoun and Shebeen El- Kom districts in Menoufia in Egypt (Figure 8). **Shebeen El- Kom** was selected for this study because it is the capital of Menoufia province and it has all services for agriculture and veterinary. Shebeen El- kom is located in middle of Menoufia and shares borders with the districts of Barket El- Sabah and Qussna to the East, El-Shohada and

Menouf to the West, Talla to the North and El-Bagour to the South. The covering area of Shebeen is 187 km^2, the district population in 1996 was estimated about 303759 inhabitants, the cultivated area is 27993 Feddan and the number of holders 32369. Shebeen El- kom is composed of 36 villages, 14 veterinary units and the 4 artificial insemination centers. The number of Extension workers in Menoufia reached about 144. 35810 buffaloes and 19858 cows produce about 18203 tons of milk and 3288 tons of meat. This represents 12.45% of the total milk production of Menoufia and 8.5% of meat production in Menoufia (GAAMG, 2002).

Figure 8. Map of Menoufia showing the location of the study areas



Source: The central administration of statistics of Menoufia governorate (1999).

Ashmoun district the second selected site for this study it is far from the capital of Menoufia. Ashmoun is located in South, it is the largest district in Menoufia, and a large number of animals and production is concentrated here. Ashmoun shares borders with the districts El- Bagour, Menouf and Sadat in the North, Kaliobia Governorate in the East and South, Giza Governorate in the West. The covering area of Ashmoun is 307 km^2, the district population in the last census 1996 was estimated about 534801 inhabitants, and 44283 farm households produce on 63296

Feddan. Ashmoun is composed of 56 villages, 16 veterinary units and 6 artificial insemination centers. The number of Extension workers reached about 123. 54582 buffaloes and 32661 cows produce about 28347 tons of milk and 8637 tons of meat. This represents 20% of the total milk production of Menoufia and 22.3% of meat production of Menoufia (GAAMG, 2002).

This study included three villages in each district. The villages El-Mesalha, Bakhaty, and Shobra kalfon are, 1.5, 5.5, and 10 Km away from the town of Shebeen El-Kom. The cultivated area in these villages are 659, 1446, and 1091 Fadden, respectively and the number of landholders in the agricultural cooperative are 728, 1513, and 1051 holders, respectively. The buffalo holders in the agricultural cooperative of the studied villages in Shebeen El-Kom are 256, 586, and 276 holders, respectively. The villages Sobk El-Had, Shanshour, and Sarawa are 3, 8, and 14 Km away from the town of Ashmoun. The cultivated areas in these villages are 2515, 2265, and 1197 Feddan, respectively, and the numbers of landholders in the agricultural cooperative are 2105, 1875, and 934 holders, respectively. The buffalo holders in the agricultural cooperative of the studied villages in Shebeen El-Kom were 1700, 1050, and 620 holders, respectively. The distribution of sample members among the six villages studied is given in Table 15.

Table 15. Distribution of sample members in different villages studied

District	Villages	Cultivated area (Fed)	No. of land holders	No. of Buffalo holder	Distance
Shebeen El-Kom	El-Mesalha	659	728	256	1.5
	Bakhaty	1446	1513	586	5.5
	Shobra kalfon	1091	1051	276	10
Ashmoun	Sobk El-Had	2515	2105	1700	3
	Shanshour	2265	1875	1050	8
	Saarawa	1197	934	620	14

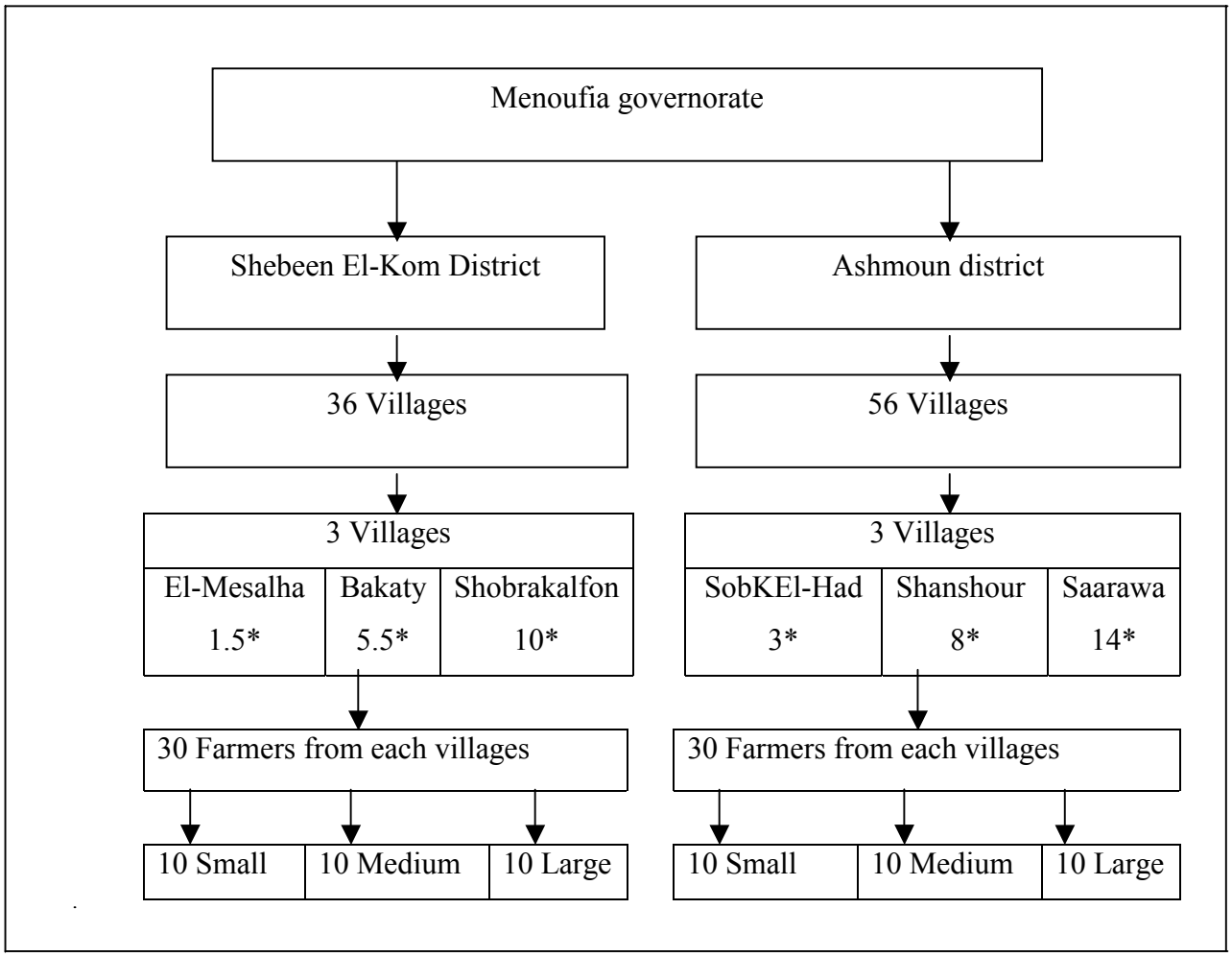
General Administration of Agriculture, Menoufia Governorate, Egypt (2002).

4.3 Sample procedures

A sample of 180 buffalo dairy farmers was selected from all buffaloes holding in the six villages included in this study; 90 from Shebeen El- kom district and 90 from Ashmoun district in Menoufia governorate in Egypt. The respondents were stratified according to distance to the district center and to the landholding. Further sampling criteria were the number of buffaloes holding registered for farmers at the agricultural co-operative of each village. Individual

households were selected randomly. The distribution of sample members among the six villages is given in (Figure 9).

Figure 9. Distribution of sample members in different villages studied



*Distance (km) between the village and the district.

4.4 Identifying the case technologies

The case technologies were selected from technologies package introduced by the Ministry of Agricultural and Land Reclamation of Egypt in the last three decades in order to improve the milk productivity in smallholder dairy buffalo in Menoufia Governorate in Egypt (MALR, 2001;Bali, 1996).

The package of technologies consists of several technological components including husbandry, feeding, hygiene or animal health, housing, and improved animals. Each package consists of a number of single technologies. The main components are shown in Table 16. The package of

technologies consists of several technological components including husbandry, feeding, hygiene or animal health, housing, and improved animals. Each package consists of a number of single technologies. The main components are shown in Table 16.

Table 16. Identifying the case technologies

Technologies components	Single technologies
Housing and management innovations	• Milking place • Milk storage of in a refrigerator • Calf pen • Stable hygiene
Health innovations	• Vaccination of buffalo against F M D* • Vaccination of buffalo against Brucellosis • Ecto parasites treatment of buffalo • Endo parasites treatment of calves
Feeding innovations a. Purchased feed b. Green fodder innovations	 • Concentrate feed for buffaloes • Mineral salt for buffaloes • Use milk replacements for the calves • Maize silage • Fodder beet
Reproduction innovation	• Artificial insemination

*= Foot and mouth disease

4.5 Explanation of independent variables and Hypotheses for selected characteristics

A number of studies have been investigating the influence of various factors on the willingness of decision makers to use new innovations. These studies have been concerned with personal, situational, and social factors associated with the adoption behavior and innovativeness of farmers. The majority of the Egyptian studies, however, have been concerned with factors associated with the adoption behavior of farmers rather than with their innovativeness. The anticipated relationships in the buffalo dairy innovation adoption, which were derived from the theoretical and empirical literature on adoption behavior, are listed below. The listing is organized according to the specific dependent variables, which are being tested in the logistic and linear regression analysis.

1. Farmer's age

Several studies, reported relationship between the age of farmers and adoption of innovations. However, it may be that young farmers are more likely to adopt new innovations and bear more

risk than older counterparts because they have more education and have been exposed to new ideas than older farmers. When the experience is combined with resources and authority, older farmers might be more willing to try out new ideas than young farmers. A Farmer's age (X1) can either generate or erode confidence in new technology. This variable is related inversely related ton adoption buffalo dairy technology (BULALE, 2000).

2. Household size

Family size seems to be affecting the type of technologies. Farmer with larger holdings are more likely to adopt lumpy technologies than those with smaller holdings because adoption costs relative to farm size are lower. Divisible technologies such as concentrate feeds, mineral salts, and dipping can be adopted equally well by all farmers as the relative costs of adoption remain equal (FEDER et. al, 1985; CIMMYT 1993.). Thus, household size (X2) is expected to be positively related to the probability of adopting improved buffalo technologies.

3. Hired labor

Labor availability is another often-mentioned variable affecting farmers' decisions about adoption of new agricultural technologies and inputs. Some new technologies are relatively laborsaving, and others are labor using. Hiring labor (X3) is hypothesized to be positively related to the adoption of buffalo dairy technologies (GETAHUN et al., 2000 and BULALE, 2000).

4. Level of education of manger

The overwhelming majority of studies found a statistically significant positive relationship between literacy and education and the adoption behavior of farmers. Exposure to education (X4) will increase the farmer's ability to obtain, process, and use information relevant to the adoption of buffalo dairy technologies (MUSSEI et al., 2001). Education is thus expected to increase the probability of adopting buffalo dairy technologies package.

4. Social participation

Participation in social and organizational activities is expected to have an indirect influence on the adoption behavior of farmers. It links the individual to the larger society and exposes him to a

variety of ideas. Indeed an overwhelmingly large proportion of studies found a significant positive relationship between the social participation and adoption (GETAHUN et al., 2000). Member of an organization are in a privileged position with respect to other farmers, in terms of their access to information on improved buffalo dairy technologies. Being a member of an organization (X5) is hypothesized to be positively associated with the adoption of improved buffalo dairy technology (DASGUPTA, 1989 and El-MEKAWY, 1996).

6. Cosmopoliteness

Contact with the world outside the village and especially urban centers links the farmer with the larger society, which has a positive influence on his level of consciousness and outlook. Exposure to a wide variety of ideas and information obtained through this outside contact makes the farmer progressive in outlook and "cosmopolite" in orientation which is defined as "the degree to which an individual's orientation is external to particular system." Contact with the external world must be viewed as an initiator of the drive towards a more modern life. In turn, cosmopolite communication enables the farmer to maintain and increase its interest in modernizing ideas. Cosmopolitans (X6) will increase the farmer's ability to obtain and use information relevant to the adoption of improved buffalo dairy technologies. Cosmopolitans are thus expected to increase the probability of adopting buffalo dairy technologies package (DASGUPTA, 1989)

7. Mass media Exposure

There is agreement among most research studies, that there is a relationship between exposure to mass media and adoption of innovations. Exposure to mass media (X7) will increase the farmer's ability to obtain and use information relevant to the adoption of buffalo dairy technologies. Mass Media is related positively to adoption of buffalo dairy technologies package (BALI.1996 and EL-GAMRINI, 1998).

8. Contact with extension workers

A relationship between extension contact and adoption has been reported by all studies. Extension contact has a direct influence on adoption behavior of farmers. The greater the degree of contact of farmers with extension personal, the greater are the possibilities of farmers being influenced to adopt agricultural innovations. Agricultural extension services provided by the ministry of

agriculture are the major source of agricultural information in the study area. It is hypothesized that contact with extension workers (X8) will increase farmer's likelihood of adopting buffalo dairy technology (MUSSEI, 2001).

9. Contact with veterinarians

Contact with veterinarian has a positive influence on the level of consciousness of farmers. A positive relationship between veterinarian contact and adoption of innovations has been reported by all studies in Egypt. Veterinary services provided by the administration of veterinary service are the major source of animal production information in the study area. It is hypothesized that contact with Veterinarians (X9) will increase farmer's likelihood of adopting buffalo dairy (EL-MELEGI, 2000 and EL-MEKAWY, 1996).

10. Wealth index

Wealth index is a commonly used indicator of farmers' economic resources. Therefore, in most studies wealth index is positively correlated with the adoption of buffalo dairy technologies. Wealth index (X10) is a proxy for wealth, and wealthier farmers have the means to purchase buffalo dairy technologies. Therefore, Wealth index is expected to be positively to the related to adoption of buffalo dairy technologies. (MIZHER, 2002 and SALAMA, 2001).

11. Farm size

The majority of the research studies handling this factor reported a significant relationship between farm size and adoption. Rogers (1995) for example, had generalized that: "Earlier adopters have larger units (farm, companies, and so on) than later adopters". Owners and operators of large-sized farms have the economic resources, and can afford to take the risk involved in trying out a new idea or practice. Many agricultural innovations require substantial economic resources and a relatively large-sized operation for their adoption and use. Farm size (X11) is an indicator of wealth and perhaps a proxy for social status and influence with a community. It is expected to be positively associated with the decision to adopt buffalo dairy technologies. Conversely, farm size can also encourage farmers to their crop; in that case it is expected to be negatively related to the adoption of buffalo dairy technologies.

12. Credit

One of the major causes of differential rates of adoption among farmers was a differential access to credit. Access to credit is one way to improve farmer access to new production technology and increase farmer's ability to purchase inputs such as concentrate feed and mineral salts which are particularly important. Farmers who have access to credit (X12) can relax their financial constraints and therefore buy inputs. It is expected that access to credit will increase the probability of adopting buffalo dairy technologies. Credit is related positively to adoption of buffalo dairy technologies (BULALE, 2000).

13. Animal unit

The majority of the research studies reviewed tackling the relationship between herd size and adoption, reported the existence of a significant relationship between these two variables. Livestock ownership (X13) is a proxy for wealth, and correlated with means to purchase buffalo dairy innovations. Therefore, ownership of livestock is hypothesized to be positively related to the adoption of buffalo dairy technologies (MUSSEI et al., 2001; GETAHUN et al., 2000 and El-MELEGI, 2000).

14. Milk Sales

Milk sales (X14) have a positive influence on adoption. Farmers who are integrated in the milk market receive a monetary payback, which increase financial liquidity. This will increase the farmers' ability to adopt capital-intensive technologies, and also stimulates the adoption of those technologies that directly improve milk yield, such as feeding technologies. Thus, milk sales are positively related to adoption of buffalo dairy technologies (BATZ, 1999).

15. Additional income

Farmers with limited access to capital are less likely to adopt technologies that require lumpy capital outlay (e.g. milking place) they are rather more likely to adopt divisible technologies such as concentrate feeds, silage maize, mineral salts, ecto and endo parasitic treatment. Most of the studies reported no relationship between additional income and adoption of agricultural innovations. Additional income is the most important indicator of the economic status of a

farmer. Access to additional income (X15) enables farmers to purchase inputs and is expected to have a positive influence on the adoption of buffalo dairy technologies (CIMMYT, 1993).

16. Distance to places of supply

Poor access to information has a negative effect on the adoption of all technologies. Greater distance to market and services decreased the odds of adoption perhaps distance adds to costs odds a new innovation and reduces potential net benefits.

With respect to the infrastructure it is assumed that farmers' access to farm inputs, information and marketing facilities depends on the distance of their farm to the places of supply. Distance to veterinary unit (X16) and the next milk collection point (X17) are expected to be negative by related the adoption of buffalo dairy technologies.

17. Complexity

Any idea may be classified on the complexity-simplicity continuum. An innovation, which is relatively simple to understand, is expected diffuse quickly. Diffusion of an innovation, which is too complex to communicate and to apply, is slow. Some innovations are clear in their meaning to potential adopters whereas others are not. The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate and speed of adoption (Rogers 1995).

18. Relative profitability

The relative advantage of an innovation is measured by its economic profitability. The relative profitability of an innovation, as perceived by members of a social system is positively related to its rate and speed of adoption.

19. Cost

Technology with low initial cost is more adopted than the high initial cost. Low initial cost has a positive influence on the rate and speed of adoption.

20. Relative investment

The rate and speed of adoption is determined by the relationships between initial cost and relative profitability.

4.6 Data collection

4.6.1 Questionnaire survey

The formulation of the questions and the order in which they are asked is determined by the questionnaire. The design of the questionnaire requires pervious knowledge of the subject of study and a hypothesis or theory, which will be validated. The surveys are most useful to generate data to prove the validity of the theories or hypotheses or to answer the specific questions. Data was collected through personal interviews of 180 buffalo (3 per day) holdings in a one-visit interview, 90 from Shebeen El- kom and 90 from Ashmoun districts. Questionnaires were pre-tested regarding clarity on a limited number of farmers who had good farm experience. The questionnaire is presented to all respondents in the same way and questions were not modified. Some of the information collected through interview was supported by observation. The data are collected during the period from August to November 2002 by the author. The data collected through interview covered the variables listed in (4.5) and are classified as follows. Farming circumstances farmer's characteristics, farm characteristics, and technologies information. Furthermore, it was noted that collection of reliable information on income from farmers was to difficult in a once off survey.

Farming characteristics

Information on farming circumstances referred to the infrastructure and access to markets. With respect to the infrastructure it is assumed that farmers' access to farm inputs, information and marketing facilities depends on the distances of their farms to the places of supply. Access to farm inputs and information is determined by the distance from the farm to the district town and veterinary unit. This is the place where most of the farm inputs can be purchased and where the divisional extension officer is based. Access to marketing facilities is determined by the distance between the farm and the next milk collection point.

Farm characteristics

Farm characteristics include the farm size, labor, herd size, milk sales, and additional income. Information collected on farm sizes took into account the total area operated and owned.

The labor capacity of farm household was estimated based on the number family members working permanently on farm and the number of hired labor.

Characterization the land-use pattern and the dairy sub-system was done by assessing the Feddan allocated to cash crop, food crops, and animal feeds, and the type and number of animals kept on the farm. The characterization of dairy sub-system included information on the performance of buffalos, and dairy marketing.

The performance of buffaloes was assessed by asking the farmers for information on milk yield. Since farmers don't keep records, a simplified approach was used. It involved asking farmers about main parameters of the lactation. These parameters are:

- The Average milk yield /day at the first, the middle, and the last part of lactation.
- The length of the lactation period.
- The total milk yield of the lactation period

Farmer's characteristics

Information on age of farm manger, gender of the farmer, family status, household size, level of education of farmers, access to credit, social participation, cosmopoliteness, mass media exposure, contact with extension and veterinarian, wealth index, and access to credit.

Technologies information

Information were collected on awareness of buffalo's dairy innovations, source of information, adoption of buffalo's dairy innovations, continuant adoption, the reasons for adoption, reasons for non-adoption and discontinuance, and advantage or reasons for adoption of buffalo dairy innovations.

Some of the difficulties which were met during data collection are: Shortness of the time forced to collect data from the farmers and the extension workers (some extension workers were not more in office and subsequently dropped from interviewing) long distance to framers and lack of transportation facilities, and difficulty in collecting reliable information on land and animal productivity.

4.6.2 Secondary source of data

In order to throw light on adoption of innovations in smallholder dairy buffalo in Menoufia Governorate, it was necessary to collect some other data material based on the following sources:

- Personal communication with responsible people in Ministry of Agriculture and General Administration of Veterinary Service in Cairo and Menoufia.
- Agriculture co-operative of villages included in this study to describe farm population, land use and distribution, land and livestock productivity.
- Statistic yearbook, center of decision-making, General Administration of Agriculture Extension in Menoufia.
- Agricultural extension and rural development research institute, animal production research institutes.
- Central administration of agriculture economic.
- Statistical yearbook, CAMPAS.
- Arab Organization for Agricultural Development (Arab agricultural statistics year book).

4.7 Analysis of data

Data were first recorded and coded and then analyzed by SPSSX 10.0 statistical package (during June and July 2003) at the Humboldt University, Institute of Animal Science. Descriptive statistics, means, variances, standard deviations, and percentages were computed for gender of manger, family size, level of education, land holding and use pattern, area under cultivation, social participation, cosmopoliteness, mass media exposure, contact with the extension and veterinarian, level of living, crop input and yield, livestock number and composition, buffalo herd composition. Multiple linear regression was used to test the effect of technology characteristics on rate and speed of adoption. Analysis for factors affecting the adoption of fourteen buffalo dairy production, namely: AI, Concentrate feed, mineral salts, milk replacement for calves, fodder beet, making silage from maize, Vaccination buffaloes against foot and mouth disease,

vaccination buffaloes against brucellosis, Ecto parasites treatment, Endo parasites treatment, milking place, calf pen, storage milk in refrigerator and Cleaning /disinfections stable), were carried out using multivariate logistic variation model.

4.7.1 Statistical analysis of farmer's adoption behavior

The influence of farm and farmers characteristics on technology adoption was analyzed using logistic regression model (MENARD, 1995). A multivariate logistic regression model is usually written in terms of log of odds, which is called logit, as:

$$\text{Log (Prob event / Prob no event)} = \text{Log } P(x)/1\text{-}P(x) = B_0 + B_1X_1 + \ldots\ldots\ldots\ldots + B_kX_k \quad (1)$$

$$P(X)/1\text{-}P(X) = \text{Odds Ratio} \quad (2)$$

Where B_0= constant, $B_{1\ldots k}$= Vector of unknown coefficients which can be interpreted as the net influence of the vector of independent variables on adoption of new innovation and $X_{1\ldots k}$= Independent variables.

In the simplest form, an odds ratio of the probability that some event occur over the probability that some event will not occur. The logistic coefficient is interpreted as the change in the log odds associated with one unit change in the independent variable. The coefficients do not measure marginal effects of independent variables but only show if any variable has a significant influence on the dependent variable. The significance of the estimated coefficients may be shown in terms of Wald statistic, which is used to test the statistical significance of an individual coefficient, the Wald is calculated as $W^2_k = (b_k/\text{standard error of } b_k)^2$, t ratios, correlation coefficients or E (B), i.e. expected value of B. Among these, E (B) gives a more direct interpretation of B and rewriting equation 2 in terms of odds rather than log odds as follows derives it:

$$\text{Prob (event) / Prob (no event)} = e^{B0 + B1X1 + \ldots\ldots\ldots\ldots + BkXk} \quad (3)$$

Now, e raised to the power of B_i is the factor by which the odds change when the independent variable increases by one unit. If B_i is positive, E (B_i) >1 which means that the odds ratio are increased. If B_i is negative, E (B_i) <1 it means that the odds ratio are decreased. If $B_i = 0$, E (B_i) =1, leaves the odds unchanged. In the logistic regression analysis, maximum likelihood method is used to estimate the parameters (KLEINBAUM, 1994). The adoption rates were calculated from the resulting logistic regression analysis using the following Formula (SPSSX 10.0):

$$P = e^x / 1 + e^x \quad (4)$$

Where X is obtained from the logistic regression equation, P = the probability of adoption, e = the base of natural logarithm.

Formula (5) represents the basic empirical model to be tested. The explanatory variables are those thought to influence farmers' decision-making concerning the adoption of a single technology. This basic model is modified for each technology. It is assumed that the adoption of one technology is likely to have stimulated the adoption of another one, so the respective technology is included in the basic model as an explanatory variables.

$$Zi = a + B_1 Age + B_2 \text{ Family size} + B_3 \text{ Hired labor} + B_4 \text{ Level of education} + B_5 \text{ Social Participation} + B_6 \text{ Cosmopoliteness} + B_7 \text{ Mass media exposure} + B_8 \text{ Contact with extension} + B_9 \text{ contact with veterinarian} + B_{10} \text{ Wealth index} + B_{11} \text{ Credit} + B_{12} \text{ Farm size} + B_{13} \text{ Animal unit} + B_{14} \text{ Milk sales} + B_{15} \text{ Additional income} + B_{16} \text{ Distance to veterinary unit} + B_{17} \text{ distance to next milk collection point.} \quad (5)$$

Where: Zi = Cumulative logistic probability function
a = Constant
$B_1..B_n$ = Regression coefficients

The independent variables in the logistic regression analysis are presented in the (Table 17)

Table 17. The independent variables used in the logistic models

Variable	Type of variable
Age of farmer	Continuous
Family size	Continuous
Hired labor	Binary
Level of education	Continuous
Social participation	Continuous
Cosmopoliteness	Continuous
Mass media exposure	Continuous
Extension	Binary
Veterinarian	Binary
Wealth index	Continuous
Credit	Binary
Farm size	Continuous
Animal unit	Continuous
Milk sales	Binary
Additional income	Binary
Distance to veterinary unit	Continuous
Distance to next milk collection	Continuous

4.7.2 Explaining the rate and speed of adoption of buffalo dairy technology (MALAR)

The survey included the collection of information on the adoption of buffalo dairy innovations in Menoufia governorate in Egypt. Farmers were asked, did you use the technology? And, if the respondents answer yes, he was asked about the date of the first use of this Technology. The rate of adoption (AR_{2002}) and the speed of adoption up to year of the survey ($speed_{2002}$), were calculated to describe the history of adoption. AR_{2002} indicates the percentage of the farmers that had adopted the technology by 2002 (6). $Speed_{2002}$ was measured by dividing AR_{2002} by the number of years between the year of first adoption and 2002 (7).

$$AR_{2002} = N_{CA}/N_{PA} \quad (6)$$

$$Speed_{2002} = AR_{2002}/t\ (1\ldots2002) \quad (7)$$

Where: AR_{2002}= rate of adoption by 2002.
N_{CA}= number of current adopters.
N_{PA}= number of potential adopters.
t(1…2002)= time from start of adoption to 2002

4.7.2 Explaining the rate and speed of diffusion of buffalo dairy technology introduced by MALR

The survey included the collection of information on the diffusion of buffalo dairy innovations introduced by the MALR. The respondents were asked if they had ever heard about the innovation; if the respondents answer yes, he was asked about the date of the first hearing about this innovation. Using these data the rate of diffusion (DR_{2002}) and the speed of diffusion up to year of the survey (speed of D_{2002}) were calculated.

4.7.3 Attributes of innovations and statistical analysis

Attributes of innovation was based on a scoring approach using assessments made by extension workers in Shebeen El-kom and Ashmoun districts in Menoufia governorate in Egypt. This approach becomes necessary because there were no data available that would provide information on the relationship between production performance and the use of specific buffalo dairy innovations. Moreover, collection of such data to estimate profitability and complexity attributes of each innovation. For the purpose of this study, it was assumed that the extension workers could provide a good assessment of the innovation characteristic. Extension workers were asked to assess new and traditional technologies taking into account the local conditions under which the farmers operate.

For estimation of profitability and initial cost assessment, extension workers were asked to give scores from 1 to 9 for each technology considered. They were required assigned low scores to technologies with low profitability or costs, and high scores to those with high profitability or costs.

$$\text{Relative profitability} = \frac{\text{Profitability of new technology}}{\text{Profitability of old technology}} \quad (8)$$

The end results obtained from equation (8) could be integrated as an indicator of profitability of new technology over traditional technology. If the end result is below 1, the new technology is inferior to the all old technology.

For assessment of the initial cost of the technology, extension workers were asked to estimate the cost for the smallest unit of the technology that the farmer could purchase (the cost for one AI, one mineral salts, one ton silage from maize, one Mel liter ivomac, one dose deworming treatment for calves, one milking place, one calf pen, and one spraying housing). To assess the relative investment, an index was calculated that expressed the relationship between initial cost and profitability.

$$\text{Relative investment} = \frac{\text{Initial costs}}{\text{Relative profitability}} \quad (9)$$

A high related investment index means that the initial cost were high compared with the additional profit.

Finally, to evaluate the complexity, extension workers were asked to give scores from 1 to 3 for each technology considered. Relative complexity assessed by dividing scores for the new technology by those for traditional technology.

The influence of attributes of innovation on the rate and speed of adoption was analyzed by using the linear regression analysis.

$$AR_{2002} = B_0 + B_1\text{time} + B_2 \text{ relative complexity} + B_3 \text{ relative investment} + e \quad (10)$$

$$\text{Speed}_{2002} = B_0 + B_1\text{relative complexity} + B_2\text{relative investment} + e \quad (11)$$

Where: time = Number of years elapsed between start of diffusion and 2002.
AR_{2002} = Rate of adoption by 2002
Speed_{2002} = Speed to AR_{2002}
B_0 = Constant
$B_{1\ldots n}$ = Regression coefficient for variable 1…2

5 Results and discussion

This chapter presents and discusses the empirical results of the study. The adoption study was conducted to analyse the influence of farming circumstances, farm characteristics and farmer characteristics on the adoption of buffalo dairy innovations. It describes the dairy farming system in Shebeen El-Kom and Ashmoun districts of Menoufia Governorate. It analyses statistically how they have influenced farmers' decisions in adopting dairy innovations, and analyses the influence of characteristics of innovations on the rate and speed of adoption.

This chapter also includes reasons for non- adoption and discontinuation of innovations and reasons for adoption of buffalo dairy innovations.

5.1 Infrastructure in the study areas

The description of the local infrastructure in Shebeen El-Kom and Ashmoun districts includes information about the distances that farmers have to travel in order to reach places of input supply, services and marketing, i.e. to Shebeen El-Kom and Ashmoun town, to the veterinary services, and to the next milk collection point.

Table 18. Distances from farms to places of input supply, services and marketing

Distance from farm and to	Mean	Std. Dev.*	Minimum	Maximum
Whole sample				
District town	7.6	4.4	1	16
Veterinary unit	2.2	1.6	0.1	8
Next milk collection point	0.7	0.5	0.2	3.5
Shebeen district (n=90)				
District town	6.2	3.7	1	12.7
Veterinary unit	1.7	0.9	0.1	4.5
Next milk collection point	0.7	0.4	0.1	2
Ashmoun district (n=90)				
District town	9.1	4.4	3	16
Veterinary unit	2.6	1.8	0.3	8
Next milk collection point	0.7	0.6	0.2	3.5

Source own survey based on 180 farm cases, *= Standard deviation.

Table 18 represents the average distances from the farms to Shebeen El-Kom and Ashmoun, which are 6.2 and 9.1 km, respectively, ranging from 1 to 12.7 km in Shebeen El-Kom district and from 3 to 16 km in Ashmoun district. Greater distance to Shebeen El-Kom and Ashmoun

districts may cause problems for farmers with respect to access to information, support services, and markets, which are only available in the town. Distance adds to costs of a new technology and reduces potential net benefits, and thus, decreases the odds of adoption. This also applies largely to distances between farm and the veterinary unit, with an average of 1.7 and 2.6 km in Shebeen El-Kom and Ashmoun districts, respectively, and a maximum of 4.5 and 8 km in Shebeen El-Kom and Ashmoun districts, respectively. Great distances are likely to make it difficult for many farmers to acquire information by contacting veterinarian and extension workers in Shebeen El-Kom and Ashmoun districts or veterinary units. This situation is aggravated by rather expensive transport in the districts, which few farmers can afford.

The great distances between the majority of farms and their places of input supply may make farmers to hesitate or to adopt complex technologies that require information and advice by the extension and the veterinary services.

The milk-marketing infrastructure is accessible to most farmers. The average distance between the farm and the next milk collection point is 0.7 km in the study areas. However, a few farms in Ashmoun district are up to 3.5 km away and these may find it difficult to market milk. The use the primitive (on foot, Donkeys) transportation and also bad or unpaved roads are the major problem in winter when the weather is unfavorable. Greater distance to market adds to costs and reduces potential net benefits, and thus decreases the odds of adoption.

It can be summarized that the infrastructure across the two districts differs greatly. Farmers in the Ashmoun district have generally to cover greater distances to the Ashmoun town, veterinary unit, and next milk collection point. However, access to cattle vaccination is easier for Shebeen El-Kom farmers than for farmers in the Ashmoun district.

A small-scale farming in the area is heavily affected by poor transport, bad roads, and market infrastructure, which results in low farm gate prices from products and high prices for food and inputs. High transport costs, high distribution costs and limited purchasing power of the smallholder agriculture, make marketing costs a principle factor in defining an effective market size. Farmers then have a lower incentive to produce for the market and to adopt new technologies for this process.

5.2 **Characteristics of Shebeen and Ashmoun Buffalo dairy farmers**

5.2.1 Gender of farm manager

Table 19 describes the distribution of gender for farm managers. In Ashmoun district more than 97% of farm managers are male. But in Shebeen El-Kom more than 5% are female. Male farm managers in the study areas may have to take on more responsibility on-farm because alternative employment in this area between seasons is scarce.

Table 19. Gender of farm managers at Shebeen and Ashmoun districts (Aug. 02-Nov. 02)

Gender of manager	Shebeen El-Kom N=90	Ashmoun N=90	All N=180
	Percentage of farmers		
Male	94.4	97.8	96.1
Female	5.6	2.2	3.9
Total	100	100	100

Source: Own survey

As a general rule, men are responsible for activities outside the home: they do most of the work in crop cultivation, the perform daily wage labor in agriculture and other activities such as building, carpentry etc.

Women are mostly restricted to stay at home, they have full responsibility for domestic chores: cleaning, cooking, childcare, laundry, etc. In homes where there are animals, they also do most of the work concerning livestock husbandry such as feeding and milking animals, growing of animals and cleaning stables. They have full responsibility and control over poultry and other fowls.

5.2.2 Age of sample at study areas

Age structures in Shebeen El- Kom and Ashmoun districts are presented in Table 20. The respondents were grouped into five age categories, which are: 1) less than 30 years of age, 2) from 31 to 40 years of age, 3) from 41 to 50 years of age, 4) from 51 to 60 years of age, 5) and more than 60 years of age.

Overall proportions of farmers between 41-60 years are similar at both districts with a slightly larger proportion in Shebeen El-Kom district. The smallest proportions of farmers are younger than 30 years (1.7%). Overall mean proportions of older farmers above 60 years of age in the two study areas are 21.1% and 23.4%, respectively, which somehow indicates disturbances in the generation flow.

Table 20. Age of sample at Shebeen El- Kom and Ashmoun districts (Aug. 02-Nov. 02)

Age	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Nr*	%	Nr*	%	Nr*	%
Less than 30	2	2.2	1	1.1	3	1.7
From 31-40	10	11.1	11	12.2	21	11.7
From 41-60	59	65.6	57	63.3	116	64.4
More than 60	19	21.1	21	23.4	40	22.2
Total	90	100	90	100	180	100

Source: Own survey, * = Number of farmers.

5.2.3 **Marital status of farmers**

Table 21 presents the marital status of farmers at Shebeen and Ashmoun districts. The overwhelming majority of farmers are married with both partners a live (87.7%).

Table 21. Marital status of farmers at Shebeen and Ashmoun districts (Aug. 02-Nov. 02)

Gender	Shebeen El-Kom N=90	Ashmoun N=90	All N=180
	Percentage of farmers		
Unmarried	3.3	6.6	5.0
Married	88.8	86.6	87.7
Divorced	0	1.1	0.6
Widowed	7.9	5.7	6.7
Total	100	100	100

Source: Own survey

5.2.4 Household size

Mean values for family size in the different study areas are compiled in Table 22 giving an overall mean of 7.7 persons. This strongly suggests that the vast majority of households are complex, with parents and children and excluding grandparents. However, larger families contain more than one household, with brothers and their families sharing the same roof and facilities, but

cooking separately. Household size in Ashmoun district is 8.7 persons slightly larger than in Shebeen El-Kom district (6.9 persons). The household size ranged from 1 to 18 persons at Ashmoun district and from 1 to 16 persons in Shebeen El-Kom district.

Table 22. Household size at Shebeen El- Kom and Ashmoun districts (Aug. 02-Nov. 02)

Districts	Mean	St. dev	Min	Max
Whole Sample (n=180)	7.7	3.2	1	18
Shebeen district (n=90	6.9	2.8	1	16
Ashmoun district (n=90)	8.7	3.5	1	18

Source: Own survey

5.2.5 Level of education of farmers

The level of education of farmers in the two study areas is indicated in Table 23. The overall mean for the duration of formal education in all the study areas is 7.1 years. A large share of farmers (90%) received formal education, while (10%) of farmers did not receive any formal education. 29.9% of farmers attended school for more than 9 year. Farmers in Ashmoun district are on average less educated than farmers in the Shebeen El-Kom district, but in comparison the level of education in Menoufia province is very high (70%) (CAMPS, 1998). The influence of level of education on buffalo dairy production will be discussed further in section (5.6.6).

Table 23. Level of education of farmers at study areas (Aug. 02-Nov. 02)

Districts	Mean	St. dev	Min	Max	Year of education			
					0	>0≤ 5	>5≤ 9	>9
					Percentage of farmers			
Whole Sample (n=180)	7.1	4.9	0	16	10	30.1	30.0	29.9
Shebeen district (n=90	7.3	4.4	0	16	6.6	26.0	38.9	28.5
Ashmoun district (n=90)	6.8	5.3	0	16	13.3	34.4	21.1	31.2

Source: Own survey

5.2.6 Social participation

Membership in organization in the study areas is reported in Table 24. Professional membership was measured by asking the respondents to mark the professional organization in which they are members: Agriculture Cooperatives, Village Local Council, Association of Vegetables, Association of Consumption, and Association of Society Development. All farmers in the study areas are members of the agricultural cooperative, which exist in all villages. Membership of

these cooperatives is mandatory for those farmers who had reasonable access to it, and even in satellite villages or hamlets many farmers joined. The cooperatives used to provide farmers with inputs, machinery services and credit. Farmers in Ashmoun district participated in more organizations than farmers in Shebeen El-Kom district. Members of an organization are in a privileged position with respect to access information on buffalo dairy innovations.

Table 24. Social participation at Shebeen El- Kom and Ashmoun districts (Aug. 02-Nov. 02)

Type of organization	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Nr*	%	Nr*	%	Nr*	%
Agriculture of cooperatives	90	100	90	100	90	100
Village of local council	32	35.5	44	48.9	76	42.2
Association of vegetables	27	30.0	34	37.8	61	33.9
Association of consumption	20	22.2	25	27.8	45	25.0
Association of society development	10	11.1	11	12.1	21	11.7

Source: Own survey, * = Number of farmers

5.2.7 Cosmopoliteness

Contact with the world outside the village and especially urban centers links the farmer with the larger society, which has a positive influence on his level of consciousness and outlook. Exposure to a wide variety of ideas and information obtained through his outside contact makes the farmer progressive in outlook and "cosmopolite" in orientation which is defined as "the degree to which an individual's orientation is external to a particular system"(DASGUPTA, 1989).

Cosmopolitans were measured by questions (during the last year, do you visit other surrounding villages or cities or other governorates). Farmers answering (no visit) to this question were given a score zero and those answering (weekly, monthly, 6 month, yearly) were given a score (4,3,2,1) respectively.

Based on the scores of cosmopoliteness, respondents were classified into three levels: low, medium, and high. Data analysis reported in Table 25 showed clearly that the majority of farmers had a medium level of cosmopoliteness (52%), while 22.2% had a high degree, and 25.6 had low degree of cosmopoliteness. The results indicate that farmers in Ashmoun district (33.4%) are more cosmopolitan than farmers in Shebeen El- Kom District (14.5%).

Table 25. Number and percentage distribution of farmers by cosmopoliteness at the study areas

Cosmopoliteness	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Number	%	Number	%	Number	%
Low	23	25.5	23	25.5	46	25.6
Medium	54	60	40	44.6	94	52.2
High	13	14.5	27	30.0	40	22.2
Total	90	100	90	100	180	100

Source: Own survey

5.2.8 Mass media Exposure

Mass media channels are means of transmitting messages involving a mass medium, such as radio, television, newspapers, and so on, that enable a source of one or a few individuals to reach an audience of many. Mass media can (1) reach a large audience rapidly, (2) create knowledge and spread information, and (3) lead to changes in weakly held attributes (ROGERS, 1995).

Mass media exposure was measured by the question “do you watch agricultural programs on television and/or on radio, do you read newspaper and agricultural magazines. The respondents were asked to choose one of the responses: Always=4,sometimies=3,rarely=2,no=1”.

Based on the scores of mass media exposure, respondents were classified into three levels: low, medium, and high. Number and percentage distribution of farmers by mass media exposure are presented in Table 26. More than 80% of farmers were falling in the low and medium level of mass media exposure. The proportions of farmers with a high degree of mass media exposure were 18.8% and 14.4%, and the proportions of farmers with a low degree of mass media exposure were 40% and 45.6% in Shebeen El-kom and Ashmoun Districts, respectively.

Table 26. Number and percentage distribution of farmers by Mass media Exposure

Mass media exposure	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Number	%	Number	%	Number	%
Low	36	40	41	45.6	77	42.7
Medium	37	41.2	36	40	73	40.6
High	17	18.8	13	14.4	30	16.8
Total	90	100	90	100	180	100

Source: Own survey

5.2.9 Contact with extension workers

Farmers' access to extension services is shown in Table 27. About 62.8% of farmers in both districts (65.5% in Ashmoun and 60% in Shebeen) had received an extension visit in 2001: 46.3% and 62.7% of farmers in Shebeen El-Kom and Ashmoun districts were visited once a month and once every three-months and 53.7% and 37.3% in Shebeen and Ashmoun were visited once a week.

Table 27. Farmers` access to extension services at the study areas (Aug. 02-Nov. 02)

Variable	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Nr*	%	Nr*	%	Nr*	%
No access to extension	36	40	31	34.5	67	37.2
Access to extension	54	60	59	65.5	113	62.8
Frequency of extension visits						
Once per week	29	53.7	22	37.3	51	45.2
Once per month	11	20.4	17	28.8	28	24.7
Every three month	14	25.9	20	33.9	34	30.1
Subject of message						
Feeding animal	40	74.1	50	84.7	90	79.6
Health animal	3	5.5	4	6.8	7	6.2
Husbandry animal	6	11.1	3	5.1	9	8
Breeding animal	5	9.3	2	3.4	7	6.2

Source: Own survey, *= Number of farmers.

The extension workers provided advice on technological recommendations including animal feeding, animal health, animal husbandry and animal breeding according to the survey. About 79.6% of farmers received advice on the animal feeding while only a few farmers received advice on other technological recommendations. Most farmers in Shebeen El-Kom (74.1%) and 84.7% of Ashmoun farmers wanted to be contacted by extension workers in order to obtain information about animal feeding to achieve increased production.

5.2.10 Contact with veterinarians

Farmers' access to veterinary services is indicated in Table 28. About 96.1% of farmers in both districts had received a visit by the veterinarian in 2002. 18.1% Shebeen El-Kom farmers and 26.7% Ashmoun farmers were visited once a week. While more than 80% and 70% of farmers at

Shebeen El-Kom and Ashmoun Districts were visited once a month or once every three-months, respectively.

Most of Shebeen El-Kom of 55.6% farmers and 66.7% of Ashmoun farmers wanted to be contacted by the veterinarian in order to obtain information about animal health to achieve increased production. While only a few farmers (7.2%) received advice on animal breeding.

Table 28. Farmers` access to veterinary services at the study areas (Aug. 02-Nov. 02)

Variable	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Nr*	%	Nr*	%	Nr*	%
No access to veterinarians	7	7.8	0	0	7	3.9
Access to veterinarians	83	92.2	90	100	173	96.1
Frequency of veterinarians visits						
Once per week	15	18.1	24	26.7	39	22.5
Once per month	36	43.4	36	40	72	41.7
Every three month	32	38.5	30	33.3	62	35.8
Subject of message						
Feeding animal	20	22.2	15	16.6	35	19.4
Health animal	50	55.5	60	66.7	110	61.2
Husbandry animal	14	15.5	8	8.9	22	12.2
Breeding animal	6	7.2	7	7.8	13	7.2

Source: Own survey, *= Number of farmers.

5.2.11 Wealth index

Based on the scores regarding the wealth index, respondents were classified into three levels: low, medium, and high. Number and percentage distribution of farmers by using the wealth index are presented in Table 29.

Table 29. Number and percentage of farmers by wealth index at the study areas

Wealth index	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Number	%	Number	%	Number	%
Low	54	60	45	50	99	55
Medium	29	32.2	30	33.3	59	32.7
High	7	7.8	15	16.7	22	12.3
Total	90	100	90	100	180	100

Source: Own survey.

More than 50% of farmers fall into the low level, while only 12.3% of farmers, have a high degree of wealth. Farmers in Ashmoun District were wealthier than farmers in Shebeen El-Kom district. Wealthier farmers have the means to purchase buffalo dairy technologies. The influence of wealth index on buffalo dairy production will be discussed further in section (5.6.6).

5.2.12 Farmers` use and source of credit

Table 30 shows Farmers` access to credit and the credit source in the study areas. About 32.2% of Ashmoun farmers and 38.9% of Shebeen El-kom farmers have access to credit. Most farmers (62.5%) used credit to purchase crop inputs. Farmers in Ashmoun District have more access to credit for animal production than farmers in Shebeen El-Kom District, while farmers in Shebeen El-Kom District have more access to credit for crop production. All Ashmoun farmers and 97.2% of Shebeen El-Kom farmers obtained credit from the rural bank, which is present in every major village, and whose director is an influential member of the community. However, the high interest rates are a serious disincentive to their use, as are the difficulties of access to those who do not have collateral in the form of landholding.

Table 30. Farmers` use and source of credit at the study areas (Aug. 02-Nov. 02)

Variable	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	NO*	%	NO*	%	NO*	%
No access to credit	55	61.1	61	67.8	116	64.5
Access to credit	35	38.9	29	32.2	64	35.5
Credit for crop inputs	26	74.3	14	48.3	40	62.5
Credit for animal production	9	25.7	15	51.7	24	37.5
Source of credit						
Rural bank	34	97.2	29	100	63	98.4
Commercial bank	1	2.8	0	0	1	1.6

Source: Own survey, *= Number of farmers.

5.3 Farm characteristics

5.3.1 Farm size and land ownership

Farmers in the study area are small-scale farmers. Table 31 shows that the average size of land owned is 2.7 feddan, ranging from 0 to 14 Feddan, and the average area of land rented is 0.8

feddan, ranging from 0 to 12 feddan. Farms in Ashmoun District are on average larger than those in Shebeen District.

Table 31. Farm size and land ownership in the study areas

Area	Farm size (Feddan)			
	Mean	Std. Dev.	Min	Max
All Sample (n=180)				
Land owned	2.7	2.5	0	14
Rented	0.8	1.4	0	12
Shebeen district (n=90				
Land owned	2.2	2.1	0	13
Rented	0.8	1.2	0	10
Ashmoun district (n=90)				
Land owned	3.1	2.9	0	14
Rented	0.9	1.6	0	12

Source: Own survey.

Table 32 shows the distribution of land in Shebeen El- Kom and Ashmoun districts within different size categories. It shows that Shebeen El- Kom and Ashmoun districts are dominated by micro-scale farmers with 55% of all farmers owning farms up to 2 feddan and 33.3% of farmers owning farms between 2 and 5 feddan.

Table 32. Distribution of land at Shebeen El- Kom and Ashmoun districts (Aug. 02-Nov. 02)

Area	Farm size (Feddan*)			
	0	>0≤ 2	>2≤ 5	>5
	Percentage of Farmers			
All Sample (n=180)				
Land owned	3.9	51.1	33.3	11.7
Rented	39.5	54.4	4.4	1.7
Shebeen district (n=90				
Land owned	6.7	53.3	32.2	7.8
Rented	38.9	55.6	4.4	1.1
Ashmoun district (n=90)				
Land owned	1.1	48.9	34.4	15.6
Rented	40	53.4	4.4	2.2

Source: Own survey. * One feddan=0.47 hectare

About 50% of Ashmoun farmers and 60% of Shebeen El-Kom farmers owned farms up to 2 feddan. Landholdings with more than 5 Feddan in Ashmoun District are more frequent than in Shebeen District.

5.3.2 **Labour capacity of farmers**

Table 33 presents the Labour capacity of the farms including men and women between the age of 14 and 65 years. In total, the farmers had a large number of family members (3) helping in agricultural.

As mentioned in section 5.2.1, the gender division of labour is fairly strict, with women staying at home and dealing with livestock, post-harvest processing and domestic activities, and rarely working in the fields. Women do, however, cut fodder for the livestock and some, particularly the poor and often heads of households, participate in field activities as wage laborers.

Table 33. Number of family member as a source of labor in at Shebeen and Ashmoun districts

Districts	Mean	St. dev	Min	Max
Whole Sample (n=180)	3.0	1.2	0	10
Shebeen district (n=90	2.9	1.6	0	9
Ashmoun district (n=90)	3.2	1.4	0	10

Source: Own survey.

The hired labour situation in farm households is presented in Table 34. The overall mean of farms with hired labour is 61.1% while 38.8% of farmers without do not hire labour.

Table 34. Hired labour of farm households at Shebeen and Ashmoun districts

Labor situations	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	NO*	%	NO*	%	NO*	%
Without hired labour	30	66.7	40	44.4	70	38.9
With hired labour	60	33.3	50	55.6	110	61.1
Total	90	100	90	100	180	100

Source: Own survey, * = Number of farmers.

The average of farms with hired labour in Ashmoun District is greater than in Shebeen District. The annual labour cycle has a peak demand in agriculture at the time of cotton planting (March), wheat harvest (May), cotton harvest (November) and land preparation for wheat (November). Labour wages vary between 8 and 10 L.E (1-1.2 €) for a day's work.

5.3.3 Land use pattern in study areas

Proportion and amount of cultivation area allocated for different crops in the area are indicated in Table 35. Farmers cultivate, on average, 3.15 feddan maize, which is the dominant crop produced and green fodder for animal in the area during summer. Maize area in Ashmoun District is larger (3.62 Feddan) than in Shebeen District (2.67 Feddan). The second most important crop is wheat. The overall average cultivated area under wheat is 1.09 Fadden with similar allocations in both districts. The third important crop was commercial vegetable with overall average land cultivation of 0.42 feddan. Farmers at Ashmoun and Shebeen Districts cultivated 0.47 and 0.37 feddan.

Average proportions of cultivated area for fruit crops (citrus, apple, plum, banana) were 0.30 Feddan. Farmers at Ashmoun and Shebeen districts cultivated 0.40 and 0.21 Feddan, respectively. Cotton and potatoes occupied the least proportion of cultivated area in the two districts. Households in the area allocated, on average, 2.09 Feddan Berseem (Egyptian clover) of cultivated area for fodder. Farmers at Ashmoun and Shebeen districts cultivated 2.29 and 1.89 Feddan, respectively.

Table 35. Average land use pattern at Shebeen and Ashmoun districts (Aug. 02-Nov. 02)

Land use	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Mean*	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Cash crops						
Cotton	0.31	0.99	0.13	1.05	0.22	1.03
Commercial vegetables	0.37	1.31	0.47	1.21	0.42	1.25
Fruit	0.21	0.99	0.40	1.46	0.30	1.25
Food crops						
Potatoes	0.29	0.69	0.32	0.89	0.31	0.78
Wheat	1.03	0.24	1.14	0.97	1.09	1.11
Animal feed						
Maize	2.67	1.71	3.62	3.55	3.15	2.81
Berseem (Clover)	1.89	1.06	2.29	1.57	2.09	1.35

Source: Own survey, *= Area in Feddan, one Feddan = 0.47 hectare.

5.3.4 Additional occupation of farmers

Regarding additional occupation, respondents were classified into two groups: those who have additional occupation and those who have not (Table 36). The proportion of farmers who have additional occupation is 37.2%, with a slightly higher proportion in Ashmoun than in Shebeen. Additional income is the most important indicator of the economic status of a farmer. Access to additional income enables farmers to purchase inputs and encourages farmers to experiment with farming innovations and to deal with risks of new adoptions of buffalo dairy technologies.

Table 36. Additional occupation of farmers at Shebeen and Ashmoun districts (Aug. 02-Nov. 02)

Additional occupations	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	NO*	%	NO*	%	NO*	%
Have additional occupation	32	35.6	35	38.9	67	37.2
Have not additional occupation	58	64.4	55	61.1	113	62.8
Total	90	100	90	100	180	100

*= Number of farmers, Source: Own survey.

5.3.5 Gross farm output (revenue)

Gross farm output or gross revenue was measured by income from cropping and livestock activities using information, collected from the sampled farmers. It was calculated from the valued production of crops and livestock for subsistence and for sale, excluding changes of animal herd and animal transactions (sales and purchases). When direct expenses, i.e. for seed, fertilizer, chemical, labor, expenses for animal feed, veterinary services and other variable inputs were deducted, the gross margin was obtained. Annual gross farm output, input expenditure (costs) per household and gross margin in the two districts in 2002 are presented in Table 37. The average annual gross farm output in the study area is 15418 L.E (2000 €) per household with a higher annual gross farm output in Ashmoun District than Shebeen district.

The contribution of livestock products to the gross farm income is 68.1%. The overall average annual costs in the study area are 9588 L.E (1300 €). The average annual input expenditure in the Ashmoun and Shebeen Districts are 10677 L.E (1400 €) and 8546 L.E per household in 2002, respectively.

Table 37. Annual gross farm output, gross margin and costs per household in the study areas.

Variable	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Average*	%	Average*	%	Average*	%
Gross farm output, origin						
Crops	4592	33.1	5233	30.8	4912	31.9
Livestock	9268	66.9	11744	69.1	10506	68.1
Gross income	13860	100	16977	100	15418	100
Costs						
Crops	2859	33.4	3107	29.1	2960	30.9
Livestock	5687	66.6	7570	70.9	6628	69.1
Input expenditure (costs)	8546	100	10677	100	9588	100
Gross Margin, Origin						
Crops	1733	32.6	2126	33.7	1952	34.2
Livestock	3581	67.4	4174	66.3	3878	65.8
Gross Margin	5314	100	6300	100	5830	100

Source: Own survey, *=Egyptian pound =0.13 €

The overall annual gross margin for agricultural production in the study area is 5830 L.E (770€) and livestock contributed, on average, 65.8% to the gross margin. Increased income presumably encourages farmers to experiment with farming innovations and to deal with risks of new adoptions. Farmers with high incomes are likely to be in a relatively favorable position to make changes in their farming operations, and, therefore, to be more willing than others to try new ideas and practices.

5.4 Characteristics of the dairy system

5.4.1 Herd composition

As shown in Table 38, the average livestock holding per household in the study area was 13.73 heads or 8.37 Tropical livestock units (TLU) (See Appendix A). Farmers in the Ashmoun and Shebeen Districts had a livestock holding of 9.25 TLU and 7.48 TLU, respectively.

Buffalo is the most important animal constituted on average 80.6% (6.75 TLU) of the herd in the study area. Average holdings per household for cattle, donkeys, sheep, and goats were 0.76 TLU, 0.54 TLU, 0.17 TLU, and 0.15 TLU, respectively. In general, livestock holding in Ashmoun district is larger than in Shebeen district.

Table 38. Livestock holding and composition per household in the study areas (Aug. 02-Nov. 02)

Variable	Shebeen El-Kom		Ashmoun		All	
	Mean	S.E	Mean	S.E	Mean	S.E
	N=90		N=90		N=180	
Livestock, N	11.27	0.51	16.17	1.12	13.73	0.64
Livestock, TLU	7.48	0.39	9.25	0.74	8.37	0.37
Buffalo, TLU	5.98	0.34	7.52	0.54	6.75	0.32
Cattle, TLU	0.80	0.07	0.74	0.11	0.76	0.06
Sheep*, TLU	0.11	0.01	0.23	0.04	0.17	0.02
Goats **, TLU	0.11	0.01	0.18	0.03	0.15	0.01
Donkeys, TLU	0.48	0.02	0.58	0.03	0.54	0.01

Source: Own survey, N= Number, TLU=Tropical livestock unit, S.E=Standard Error of Mean * = Rahmani, ** = Zaribi

5.4.1.1 Buffalo herd composition

Buffalo herd composition per household is presented in Table 39. The proportion of Buffalo cows is 75.42% and 79.39% in Shebeen and Ashmoun. The number of calves and heifers are higher in Shebeen District than in Ashmoun District.

Table 39. Buffalo herd composition per household (TLU) in the study areas

Variable	Shebeen El-Kom			Ashmoun			All		
	Mean	S.E	%	Mean	S.E	%	Mean	S.E	%
	N=90			N=90			N=180		
Buffalos	5.98	0.39	100	7.52	0.67	100	6.75	0.32	100
Buffalo Cow	4.51	0.25	75.42	5.97	0.48	79.39	5.24	0.28	77.62
Calf	0.46	0.04	7.69	0.44	0.09	5.85	0.45	0.04	6.67
Heifer	0.90	0.07	15.05	0.87	0.08	11.57	0.89	0.07	13.19
Bull	0.11	0.03	1.84	0.24	0.06	3.19	0.17	0.03	2.52

Source: Own survey, TLU=tropical livestock unit, S.E=Standard Error of Mean
Due to rounding of number the percentages did not add to 100

5.4.1.2 Cattle herd composition

Cattle herd compositions per households in the different study area are shown in Table 40. The overall proportion of local cows (Baladi) in the cattle herd was 45.9% (0.28 TLU) and those of crossbreed cows were 9.84% (0.02 TLU). Local cows contributed 54.23% and 32.9% of all cows kept in Ashmoun and Shebeen Districts, respectively.

Proportions of local heifers were 16.95% and 20.5% of all heifers kept in Ashmoun and Shebeen Districts, respectively. Proportions of local calves were 6.78% and 36.70% of all heifers kept in Ashmoun and Shebeen Districts, respectively. No crossbred bulls and heifers were kept.

Table 40. Cattle herd composition per household (TLU) in the study areas

Variable	Shebeen El-Kom			Ashmoun			All		
	Mean	S.E	%	Mean	S.E	%	Mean	S.E	%
	N=90			N=90			N=180		
Cattle	0.79	0.06	100	0.59	0.09	100	0.61	0.05	100
Cow, local	0.26	0.07	32.91	0.32	0.04	54.23	0.28	0.04	45.90
Cow, cross	0.03	0.02	3.80	0.09	0.04	15.26	0.06	0.02	9.84
Heifer local	0.16	0.06	20.25	0.10	0.02	16.95	0.13	0.04	21.32
Cross heifer	-	-	-	-	-	-	-	-	-
Calf, local	0.29	0.06	36.70	0.04	0.02	6.78	0.02	0.02	2.28
Calf, cross	0.02	0.01	2.50	-	-	-	0.02	0.01	2.28
Bull, local	0.03	0.01	1.27	0.03	0.01	5.09	0.03	0.05	4.92
Bull, cross	-	-	-	-	-		-	-	-

Source: Own survey, TLU=tropical livestock unit, S.E=Standard Error of Mean.
Due to rounding of number the percentages did not add to 100

5.4.2 Animal feed resources

Table 41 presents different type of feed given to the livestock in the study areas. All the farmers (100%) in the study areas used Egyptian clover to feed cattle and buffaloes during the period form November to May.

Table 41. Feed resources and their relative importance

Source of feed	Whole sample			Shebeen El-Kom			Ashmoun		
	No.*	%	Rank	No.*	%	Rank	Nr.*	%	Rank
Berseem (Egyptian clover)	180	100	1	90	100	1	90	100	1
Green fodder maize	180	100	1	90	100	1	90	100	1
Cottonseed cake	75	42	4	40	44	2	35	39	4
Soybean cake	40	22	5	20	22	6	20	22	6
Linseed cake	35	19	7	28	31	5	17	19	7
Wheat bran	29	7	8	9	10	7	20	5	8
Cereals	45	21	6	15	8	8	30	33	5
Maize silage	99	55	2	32	36	4	67	75	2
Crop residues	110	47	3	60	43	3	50	51	3

Source: Own survey, * = Number of farmers.

Maize is the main cereal crop grown in Menoufia. It is also the only green fodder available in summer. For the remainder of the year, however, crop residue from maize is the main ration component.

Clover and maize takes the first rank for feeding animal in winter and summer followed by maize silage and crop residues. In Ashmoun District more than 65% of farmers feeding animal with silage from maize. Cottonseed cake, cereals, soybean cake, linseed cake, and wheat bran are used as concentrate supplements.

5.4.3 Milking buffaloes

Milking of buffaloes by hand (100%) is carried out twice per day, at 7 o'clock in the morning and 5 o'clock in the evening. The whole milk feeding system for buffalo calves is by sulking the buffalo twice per day, which is used by more than 65% of farmers in the study areas. The average weaning age of suckled calves was 9 and 10 weeks in Ashmoun and Shebeen Districts, respectively. Methods of milking buffalo in Shebeen El- Kom and Ashmoun Districts are indicated in Table 42. About 91.2% of Ashmoun farmers and 74.5% of Shebeen farmers milking buffalo without calf present, respectively.

Table 42. Methods of milking buffalo at Shebeen and Ashmoun Districts (Aug. 02-Nov. 02)

Type of method	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	Average	%	Average	%	Average	%
Milking Without calf present	67	74.5	82	91.2	149	82.8
Milking with calf present	23	25.5	18	8.9	31	17.2
Stimulation before milking	10	11.1	2	2.2	12	6.6
Suckling followed by milking	8	8.9	2	3.3	10	5.6
Milking followed by suckling	2	3.3	3	2.2	5	2.8
Suckling before and after milking	3	2.2	1	1.1	4	2.2

Source: Own survey.

5.4.4 Objectives of buffalo breeding

The main objective of keeping buffaloes in the study areas was to obtain income and provide food for household (Table 43).

Table 43. Purpose of buffalo Breeding at Shebeen and Ashmoun Districts (Aug. 02-Nov. 02)

Type of purpose	Shebeen El-Kom N=90		Ashmoun N=90		All N=180	
	No*	%	No*	%	No*	%
Milk production	72	80.0	81	90.0	153	85.0
Milk and meat production	18	20	9	10.0	27	15.0
Total	90	100	90	100	180	100

Source: Own survey, No*= number of farmers.

90% of Ashmoun farmers and 80% of Shebeen farmers said that they produced milk both, as a source of income and for household consumption. The remaining percentages of household in both areas said they were keeping buffalo for milk and meat production.

5.4.5 Milk performance of the sample buffalo dairy herd

Data on milk performance of buffalos were collected through the survey (Table 43). The overall average quantity of milk per day in the first, middle, and end of lactations were 7.3, 9.7, and 4.5 Kg, respectively. The average yield per day in Ashmoun District was greater than Shebeen District.

Table 44. Milk performance of the sample buffalo dairy herd (Aug. 02-Nov. 02)

Variable	Mean	Std. Dev.	Min	Max
All Sample (n=180)				
Average milk yield /day (kg)	7.1	0.8	4.3	11
First	7.3	1.2	4	11
Middle	9.7	1.7	6	15
End	4.5	1	3	8.7
Total milk yield/lactation	1460	250	850	2250
Length lactation (days)	215	18	180	270
Ashmoun district (n=90)				
Average milk yield /day (kg)	7.4	0.9	4.7	11
First	7.4	1.1	5	11
Middle	10.4	1.8	7	15
End	4.5	0.7	3	7
Total milk yield/lactation	1616	271	900	2250
Length lactation (days)	217	19.3	190	270
Shebeen district (n=90)				
Average milk yield /day (kg)	6.8	0.8	4.3	10.2
First	7.1	1.2	4	10
Middle	9	1.7	6	12
End	4.6	1.1	3	8.7
Total milk yield/lactation	1305	229	850	1850
Length lactation (days)	213	16.7	180	250

Source: Own survey.

The average milk yield per lactation across to the whole sample was estimated at 1460 Kg with 1616 Kg in Ashmoun and 1305 kg in Shebeen. The lactation periods of buffalo in the study areas were very short, with an average of 215 days and a range from 180 to 270 days.

The performance of buffalo in the Ashmoun District was much larger than that in the Shebeen District. This could be linked to more favorable production circumstances and to better green fodder and larger farm size in Ashmoun District. Farmers in the Ashmoun District grew more maize in order to produce silage than farmers in the Shebeen district.

5.5 Marketing channels at study areas

The different marketing channels used mostly by dairy farmers in the study areas are shown in Table 45. About 79.4% of the farmers do sell milk. The other farmers do not market their milk, but they turn the milk into butter and cheese, as well as consuming it unprocessed. In most cases the produce is consumed within the family, though some is exchanged or sold to neighbors or in the village market every week. Among farmers who market milk, 36.2% do that through dairy societies. About 33.8% of farmers sold milk to traders ex-farm twice a day. 17.4% of farmers market the milk through local sales in the village.

In Ashmoun District only 71.1% of farmers sold milk compared to 87.7 % in the Shebeen District. However, in Ashmoun District the majority of farmers sold the milk to traders but in Shebeen District most farmers sold milk to dairy societies.

Table 45. Marketing channels at Shebeen and Ashmoun districts (Aug. 02-Nov. 02)

Type of milk marketing	Whole sample	Shebeen El-Kom	Ashmoun
	Percentage of farmers		
	N=180	N=90	N=90
No marketing	21.4	12.3	28.9
Marketing	79.4	87.7	71.1
Dairy societies	36.2	41.0	31.3
Trader milk	33.8	28.5	39.1
In the town	12.6	11.0	14.1
Local sales in the village	17.4	19.5	15.5

Source: own survey

5.6 Adoption of dairy technology in the study areas

5.6.1 Sources of information of innovation

The respondents were asked to rank their sources of information an innovation according to the most important sources (Table 46). Information sources were classified into two broad categories:

- Personal communication, which included extension workers, veterinarian, family members, neighbors, and private sector companies and traders.
- Impersonal communication, which included radio, T.V, and extension leaflets.

Personal sources were ranked by farmers much higher than impersonal sources. 89% of farmers were identified of personal communication as a source of information for innovations compared with 11% of farmers who identified impersonal communication. The farmers ranked the veterinarian on the top for reproduction, and health innovations, the second for Housing and management innovations, and the third for feed innovations. Extension workers were ranked as the fifth most important source of overall innovations. Family members and neighbors (34%) are also very important sources of information.

Table 46. Source of information of innovations and their relative importance

Type of source of information	Buffalo dairy innovations				
	Reproduction innovations	Feed innovations	Health innovations	Housing and management innovations	Overall innovations
	Percentage of farmers				
Veterinarian	40	14	42	21	29
Family members	15	19	16	23	18
Neighbors	17	16	14	18	16
Traders	10	11	11	12	11
Extension workers	8	7	7	5	7
Private sector companies	4	12	3	10	7
T.V	2	13	2	4	5
Radio	3	5	1	7	4
Extension leaflets	1	3	4	0	2
Total	100	100	100	100	100

Source: own survey

The use of the impersonal communications especially, the print media was negligible because of the low number of such media available to the farmers in the study areas. The only extension materials available were leaflets published by the academy of agriculture.

5.6.2 Assessment of technology adoption

5.6.2.1 Reproduction innovation

The relative awareness about, adoption and continuous adoption of artificial insemination (AI) and natural mating are presents in Table 47. The highest proportions (98.9%) of the farmers in the study areas were aware about the AI innovation.

Table 47. Knowledge about, adoption and continuous adoption of AI and Natural mating

Technology	Whole sample (N=180)			Shebeen district (N=90)			Ashmoun district (N=90)		
	Percentage of farmers								
	K*	A**	C***	K*	A**	C***	K*	A**	C***
AI	98.9	49.4	26.1	97.7	41.1	25.6	100	57.8	26.7
Natural mating	100	50.6	73.9	100	58.9	74.4	100	42.2	73.3

Source: own survey, K*= Knowledge of innovation, A**= adoption of innovation, C***=continuant adoption of innovations.

The data analysis indicates that the adoption of AI is poor. Only 49.4% of the whole sample used AI, while the proportion of adopters in Ashmoun district is higher than that in Shebeen District. Only 26.1% of the farmers are continuous adopters. This proportion is similar in both districts.

This low continuous adoption of AI was probably due to, firstly, natural service was available, secondly, preference is given to natural service since AI often fails, thirdly, a center of AI was non-existent in the village or too distant and lastly the farmers seems not to be convinced about the utility of AI in terms of performance improvement.

5.6.2.2 Feeding innovations

The knowledge about, adoption, and continuous adoption of new and traditional feeding innovations are shown in Table 48. The traditional feeding technologies for dairy buffalo and calves are the use of crop residues and suckling of calves. All farmers had a high awareness

about the use of concentrates (100%), maize silage (100%), fodder beet (80.6%) followed by the use of mineral salts (76.2%) and milk replacement (64.5%).

Table 48. Knowledge about, adoption and continuous adoption of new and traditional feeding Innovations

Technology	Whole sample (N=180)			Shebeen district (N=90)			Ashmoun district (N=90)		
	Percentage of farmers								
	K*	A**	C***	K*	A**	C***	K*	A**	C***
New technologies									
Concentrates	100	83.3	76.1	100	86.7	72.2	100	80.0	80.0
Mineral salts	76.2	60.5	53.3	75.6	58.8	52.2	76.7	62.2	54.4
Milk replacement	64.5	32.8	29.5	63.3	31.1	26.7	65.6	34.4	32.2
Maize Silage	100	63.4	59.4	100	56.7	54.4	100	70	64.4
Fodder beet	80.6	26.7	15.6	78.9	25.6	14.4	82.2	27.8	16.7
Traditional technologies									
Crop residues	100	93	94.5	100	91	93	100	95	96
Suckling	100	67.2	70.5	100	68.9	73.3	100	65.8	67.8

Source :own survey*= Knowledge of innovation, A**= adoption of innovation, C***=continuant adoption of innovations

The level of knowledge of feeding innovations in Ashmoun District is higher than that in Shebeen District. This high level of knowledge about feeding innovations is probably due to the increased level of education of farmers, that farmers had access to various sources of information, and that farmers in Ashmoun District had a general high degree of awareness and a good exposure to mass media.

More than 83.3%, 63.4% and 60.5% of farmers used concentrates, maize silage, and mineral salts, respectively. While the adoption of milk replacement and fodder beet is very poor. The adoptions of feeding innovations are similar in both Districts.

The high adoption of concentrates is probably due to the positive effect on profitability, the high number of farmers marketing milk (80%), which increased the ability of farmers to purchase concentrates, and the positive effect of a high protein content and in a roughage based ration.

The high adoption of maize silage was probably due to conserving fodder for dry seasons. Feeding maize silage the positive effect on milk yields, relative low cost, high palatability, and the simple to prepare. The low adoption of milk replacer is probably due to the low cost-benefit rates since calves are sold after early weaning. Low adoption of fodder beet is probably related to

in the fact that fodder beet growing is not compatible with the agricultural cycle, and the opportunity cost for land, and also due to non-availability of seeds.

5.6.2.3 Housing and management innovations

The knowledge about, adoption, and continuous adoption of new and traditional housing and management innovations are shown in Table 49. The traditional housing and management innovations of buffalo dairy innovations included conventional milking, tethering calves, traditional storage milk, and traditional cleaning stable. All farmers had a high awareness about calf pen (100%), milk storage in refrigerator (100%), stable hygiene (96.7%) followed by the milking place (78.8%).

This high level of knowledge of housing and management innovations is probably due to several factors. These factors are: increasing the level of education of farmers, contact with sources outside of the village especially in urban centers.

The adoption of calf pen and milk storage in refrigerator is high, while the adoption of milking place and stable hygiene is poor. About 79.5% and 75.6% of the whole sample farmers are using calf pen and refrigerated milk storage. The adoption of calf pen in Ashmoun District is higher than that in Shebeen District but the adoption of milk storage in a refrigerator in Shebeen District is higher than that in Ashmoun District. The high adoption of calf pen is probably due to several factors. First, it simplifies the milking process without calf. Second, to prevent transfer of diseases and protection of calves from danger. Third, control of suckling and feeding. The high adoption of milk storage in a refrigerator is probably due to avoid souring and spillage and keeping the tasty of milk.

The adoption of a separate milking place is very low. Only 38.4% of all of farmers use a milking place, slightly more in Shebeen District than in Ashmoun District. However 61.6% of farmers still prefer to use the conventional milking.

The low adoption of a separate milking place could be due to the following factors: most farmers are resource-poor and cannot afford the investment, a milking place will have a lower perceived profitability than conventional milking, milking place are complex and their construction need support from veterinarian and extension worker. Considering the distances between many farms

and the places where such information is provided, this will lead to a situation in which only a few farmers adopt this innovation.

Table 49. Knowledge about, adoption and continuous adoption of new and traditional Housing and management innovations

Technology	Whole sample (N=180)			Shebeen district (N=90)			Ashmoun district (N=90)		
	Percentage of farmers								
	K*	A**	C***	K*	A**	C***	K*	A**	C***
New technologies									
Milking place	78.8	38.4	33.4	81.1	45.6	36.7	76.7	31.1	30.0
Calf pen	100	79.5	68.9	100	75.6	64.4	100	83.3	73.3
Storage milk in refrigerator	100	75.6	57.3	100	76.6	56.7	100	74.4	57.8
Stable hygiene	96.7	59.5	54.5	95.6	58.9	56.7	97.7	60	52.2
Traditional technologies									
Conventional milking	100	61.6	66.6	100	54.4	63.3	100	68.9	70
Tethering calves	100	20.5	31.1	100	24.4	35.6	100	16.7	26.7
Traditional storage milk	100	24.4	42.7	100	23.4	43.8	100	25.6	42.2
Traditional cleaning stable	100	40.5	45.5	100	41.1	43.3	100	40	47.8

Source: own survey, K*= Knowledge of innovation, A**= adoption of innovation, C***=continuant adoption of innovations.

Slightly more than half (59.5%) of all farmers practice stable hygiene of their stables. The low adoption of stable hygiene and milking places was probably related to the limited finance and their preference not to purchase desinfections, which are the main constraints of using credit with high interest rates.

5.6.2.4 Health innovations

Table 50 presents the information on the extent of awareness, adoption, and continuous adoption of new and traditional health innovations. In general, all farmers had a high awareness about health innovations with exception of Vaccination against Brucellosis (only 59.5%).

About 86.2% and 77.1% of farmers in both Districts adopted the vaccination against foot and mouth disease and treatment of ecto parasites, respectively, slightly more in Ashmoun District than in Shebeen District. Slightly more than half (60%) of the whole sample of farmers adopted

endo parasites treatment to calves. The vaccination against Brucellosis is very poor. Only 39.5% of the farmers adopted vaccination against Brucellosis.

Table 50. Knowledge about, adoption and continuous adoption of new and traditional health Innovations

Technology	Whole sample (n=180)			Shebeen district (n=90)			Ashmoun district (n=90)		
	Percentage of farmers								
	K*	A**	C***	K*	A**	C***	K*	A**	C***
New technologies									
Vaccination against FMD	100	86.2	70.6	100	85.6	70	100	86.7	71.1
Vaccination against Brucellosis	59.5	39.5	29.5	57.8	36.7	27.8	61.1	42.2	31.1
Ecto parasites to buffalo	97.8	77.8	75.0	95.6	71.1	66.7	100	84.4	83.3
Endo parasites to calves	100	61.1	48.9	100	62.2	52.2	100	60.0	45.6
Traditional technologies									
Hand removing of ticks on buffaloes	6.6	22.2	25.0	4.4	28.9	33.3	8.9	15.6	16.7
Feeding herbs and roots to calves	15.5	38.9	51.1	16.7	37.8	47.8	14.4	40.0	54.4

Source :own survey, *= Knowledge of innovation, A**= Adoption of innovation, C***=Continuant adoption of innovations.

The high awareness and adoption rate of vaccination against foot, mouth disease (FMD) and ecto and endo parasites treatment is related to the existence of veterinary services in most of villages, and free cost of vaccinations, while the low knowledge and adoption about vaccination against Brucellosis is probably due to the low importance and attention given by veterinary service.

The continuous adoption is very high for buffalo vaccination FMD and ecto parasites treatment in the study area. While the continuous adoption of endo parasites treatment (48.9%) and vaccination against Brucellosis (29.5%) is much lower. Continuous adoption of endo parasites treatment is poor due to the farmers` preference to use alternatives for external and internal parasites.

5.6.3 Characteristics of case innovations

Innovation characteristics were measured using a scoring approach involving 50 extension workers. A scoring approach was necessary, due to the paucity of quantitative data. Most extension workers were farmers themselves, and were able to assess the relative advantage and disadvantage of innovations from a farmer's point of view.

Table 51 shows the results of the assessments of the new innovations' characteristics. The first column shows the values of relative profitability. Innovations with high profitability appear to be vaccination against foot and mouth disease, concentrates, mineral salts, maize silage, calf pen, endo parasites to calves, and refrigerated storage milk. Relative profitability was lowest for stable hygiene, AI, milk replacer, fodder beet, milking place, vaccination against Brucellosis, and ecto parasites treatment to buffalo. The relative investment assumed to be greater for AI, milk replacement, fodder beet, milking place, and stable hygiene. The scores for relative complexity range between 0.3 and 3.

Table 51. Characteristics of the buffalo dairy innovations

Innovations	Relative Profitability	Relative Investment	Relative Complexity
AI	1.48	3.04	1.7
Concentrates	4.16	1.01	0.7
Mineral salts	3.00	1.3	1.1
Milk replacement	0.73	5.06	1.5
Maize Silage	3.00	1.46	0.83
Fodder beet	1.00	5.6	2
Milking place	0.95	5.57	2.5
Calf pen	3.20	1.25	0.9
Storage milk	2.30	1.21	0.81
Stable hygiene	0.94	4.6	2
Vaccination against FMD	6.00	0.17	0.3
Vaccination against brucellosis	1.00	1	3
Ecto parasites to buffalo	2.00	2	0.66
Endo parasites to calves	3.00	0.66	0.3

Source: Own survey. Relative profitability (>1) the new innovation is more profitable than old innovation, (=1) the new innovation is neutral,(<1) and the new innovation is less profitable than old innovation. Relative complexity:(>1) the new innovation is more complex than old innovation, (=1) the new innovation is neutral, (<1) and the new innovation is less complex than old innovation. Relative investment: The higher the value the greater the investment in relation to the profitability.

The lowest score of relative complexity was 0.3 for endo parasites treatment and the highest score of relative complexity was 3 for vaccination against Brucellosis. 7 out of 14 innovations had complexity score over 1, namely: vaccination against Brucellosis, milking place, fodder beet, stable hygiene, AI, milk replacement, and mineral salts. On other hand the remaining innovations had a low complexity. The high complexity of vaccination against Brucellosis is probably due the disease is not organise case by case and complex of veterinary service and vaccination more animals together and the farmers prefer to eradicate the buffalo that have Brucellosis. The complexity of milking place is probably due to the current building legislation, which does restrict farmers to make farm constructions.

5.6.4 Adoption of dairy innovations

The adoption patterns of the case innovations were determined by interviewing 180 farmers using questionnaires. Data were collected on the 14 buffalo dairy innovations that farmers had adopted, in terms of the year when they started to use them, the rates adopted at that time, the rates in use at the time of the survey (2002), and awareness in terms of the innovation characteristics. Farmers were asked for each innovation that they had adopted to indicate if they were actually using the innovation. Farmers who answering "yes" to this question were given a score 2 and those answering "no" were given a score 1. Characterisation of innovations was based on a scoring approach using assessment made by extension workers in the study area. The average scores for the two characteristics for 14 innovations were used as the explanatory variables in the model that assumed cumulative adoption by 2002. Speed of adoption depended on perceived innovation characteristics.

The earliest innovation, namely concentrates, which falls under feeding components, began to be adopted in 1972. Four of the innovation components were adopted in 1974, 1975, 1977, 1978, namely stable hygiene, calf pen, vaccination against foot and mouth disease, endo parasites treatment, respectively. The remaining innovations were adopted in 1980s.

5.6.4.1 Advantage or the reasons for adoption of buffalo dairy innovations

Adopters were asked to rank their three most important advantages of each innovation (I-III) (Table 52). The main advantage of adoption of AI were for 42% of Ashmoun adopters that the use of improved sires, increases performance, and increasing milk production (38%) was the main advantage felt by Shebeen adopters. About 70% of adopters said that the main reason for using concentrates was an increase in profitability. However, a significant difference was observed between Ashmoun and Shebeen Districts regarding the protein value of concentrates.

The main advantages of mineral salts mentioned by 73% of Ashmoun adopters were associated with improved fertility and a source of phosphorus. 66% of Shebeen adopters indicated that improvement of fertility and protections against diseases were the main advantages of mineral salts. Most of adopters in the two Districts have the same consideration of the advantages of adoption of milk replacement.

Table 52. Relative advantage of buffalo dairy innovations (farmer's view)

Advantages of innovations	Whole sample				Shebeen El-Kom				Ashmoun			
	Number and percentage of farmers											
	I*	II	III	%	I	II	III	%	I	II	III	%
Advantages of AI												
1. AI helps in checking the sexually diseases	14	9	-	26	7	4	-	30	7	5	-	23
2. Improves performances	24	3	3	34	6	1	1	22	18	2	2	42
3. Increases milk production	9	8	8	27	3	5	6	38	6	3	2	21
4. AI is the most economical practice	7	3	1	13	2	2	-	10	5	1	1	14
Advantages of concentrates												
1. Increase profitability	63	25	11	70	27	13	6	66	36	12	5	74
2. Palatability for buffaloes	8	6	6	14	2	3	1	9	6	3	5	19
3. The value of protein is high	5	7	11	16	3	4	11	25	2	3	-	7
Advantages of Mineral salts												
1. Increase the appetite of buffaloes	6	6	5	15	3	5	3	21	3	1	2	11
2. Source of phosphorus	14	6	3	21	4	0	3	13	10	6	-	28
3. Improve the fertility	29	7	4	37	10	3	2	28	19	4	2	45
4. Protect the livestock against diseases	9	10	10	27	7	4	9	38	2	6	1	16
Advantages of Milk replacement												
1. Helps in economical raising of calves	16	7	1	41	8	2	-	36	8	5	1	45
2. Increases number of calves for breeding	10	8	4	37	2	6	4	43	8	2	-	32
3. Increase the animal health care	5	3	2	17	-	-	2	18	5	-	-	16
4. Palatability for calves	2	-	1	5	-	-	1	3	2	-	-	7
Advantages of maize silage												
1.Saves fodder for dry season	33	4	1	33	11	-	-	24	22	4	1	39
2. Balances feed	12	6	2	17	7	1	1	20	5	5	1	16
3. Increases the milk production	12	11	8	27	-	6	1	15	12	6	6	34
4. The cost is low	3	5	5	11	3	4	5	26	-	1	-	1
5. Increases Palatability for buffaloes	3	4	-	6	-	4	-	9	3	-	-	4
6. Simple to prepare	-	4	3	6	-	-	2	7	-	2	2	6
Advantages of Fodder beet												
1. Yield per Feddan is high	5	6	-	23	4	3	-	32	1	3	-	15
2. Increase the milk production	4	6	-	21	2	3	-	23	2	3	-	19
3. Palatability	6	2	1	19	1	1	-	9	5	1	1	27
4. The cost is low	1	3	1	10	1	2	-	14	-	1	1	8
5. Preserve fodder for dry season	12	1	-	27	5	-	-	23	7	1	-	31
Advantages of milking place												
1.Cleanness of milk and place	19	13	6	59	12	8	6	63	7	5	0	52
2. Cleaning and washing buffaloes daily	13	4	3	31	10	2	3	37	3	2	0	22
3. Improves the milking process	6	-	-	10	-	-	-	0	6	-	-	26
Advantages of calf pen												
1. Controls suckling and feeding	30	9	3	29	12	4	2	24	18	5	1	34
2. Prevent transfer of diseases	37	16	5	38	16	10	3	40	21	6	2	41
3. Simplifies the milking process without calf	30	16	6	33	15	5	6	36	6	11	-	25

Source: Own Survey, *I, II, III = Farmers ranking of importance of the Reasons adoption of buffalo dairy innovations, (I = most important).

Maize silage seems to have the main advantage in preserving fodder for the dry season, while simple to prepare got last rank. Relatively more Ashmoun adopters appreciate the value of silage for milk production than adopters in Shebeen. Ashmoun adopters reported that preserving fodder for the dry season was the main advantages of adoption of fodder beet compared to the highest yield per Feddan.

Table 52. Continued

Advantages of innovations	Whole sample				Shebeen El-Kom				Ashmoun			
	Number and percentage of farmers											
	I*	II	III	%	I	II	III	%	I	II	III	%
Advantages of milk storing												
1. Avoid souring	36	13	2	36	19	8	1	36	20	5	1	39
2. Avoid Spillage	25	12	10	34	14	5	4	38	11	-	6	25
3. Keeps the taste of milk	19	12	4	30	6	8	4	26	13	11	-	36
Advantages of stable hygiene												
1.Clean milk and buffaloes	19	12	3	31	7	5	2	27	12	7	1	37
2. Kill the insects	26	10	0	34	18	6	-	45	8	4	-	22
3.Protect the buffaloes against diseases	20	12	5	35	6	9	-	28	14	3	5	41
Advantages of Vaccination against FMD												
1. Protects against foot and mouth disease	86	11	4	68	31	5	2	53	55	6	2	82
2. Increases the milk production	9	9	5	15	4	7	5	22	5	2	-	9
3. Decreases the cost of Vet. Medicine	6	3	1	7	-	3	1	3	6	-	-	8
4. No charge	-	5	4	6	-	5	4	12	-	-	-	0
5. Decreases the death of calves	4	-	2	4	3	-	2	10	1	-	-	1
Advantages of Vacc against Brucellosis												
1. Protects against abortion	36	19	-	77	17	14	-	94	19	5	-	63
2. Increases the milk production	1	3	-	6	-	-	-	0	1	3	-	11
3. No charge	2	10	-	17	-	2	-	6	2	8	-	26
Advantages of Ecto parasites treatment												
1. Effectiveness to ecto and endo Para	59	10	2	50	24	7	2	51	35	3	-	51
2.Increases appetite of buffaloes	18	14	1	24	6	4	-	16	12	10	1	31
3. Increase the profitability	5	10	1	12	3	9	-	19	2	1	1	5
4. Eradication of worms	16	3	-	14	9	-	-	14	7	3	-	13
Advantages of Endo parasites treatment												
1. Exterminates internal parasites	39	23	2	63	19	15	-	61	20	8	2	67
2.Increase appetite of buffaloes	15	10	-	15	10	8	-	14	5	2	-	16
3.Improve the growth	4	8	-	22	-	4	-	25	4	4	-	17

Source: Own Survey, *I, II, III = Farmers ranking of importance of the Reasons for adoption of buffalo dairy innovations, (I = most important).

Most adopters (78%) in the Ashmoun District indicated that cleanly of milk and place and ease of milking process were advantages of adoption of milking place. Prevention of transmission of diseases and simplicity of milking process without calf were indicated as advantages of a calf pen by 76% of Shebeen adopters. Adopters in the study areas reported that storing milk in a refrigerator improved the quality of milk. 78% of Ashmoun adopters relate advantages of stable

hygiene with cleanness of milk and buffaloes and protection against diseases, while only 55% of Shebeen adopters appreciate the above advantages.

The main advantage of adoption of vaccinating buffaloes against FMD and Brucellosis was the effectiveness of protection. Obviously most adopters in the two Districts reported that the main advantage of using insecticides was to remove ecto and endo parasite treatment.

5.6.4.2 Cumulative adoption by 2002

The cumulative percentage of farmers using the case innovation by 2002(Table 53) presents the current rate of adoption (cumulative % adoption by 2002).

Table 53. Adoption of buffalo dairy innovations

Technologies	Year of the first adoption	Cumulative adopters by 2002	Speed of adoption per year
AI	1981	49.4	2.4
Concentrates	1972	83.3	2.8
Mineral salts	1982	62.2	3.1
Milk replacement	1980	34.4	1.6
Maize silage	1989	63.3	4.8
Fodder beet	1986	26.7	1.7
Milking place	1982	38.3	1.9
Calf pen	1975	79.4	2.9
Milk Storage in a refrigerator	1980	75.6	3.4
Stable hygiene	1974	58.9	2.1
Vaccination against FMD	1977	86.7	3.7
Vaccination against brucellosis	1980	42.2	1.9
Ecto parasite treatment	1980	77.8	3.5
Endo parasite treatment	1978	61.1	2.5

Source: own survey.

Eight out of 14 innovations had over 60% cumulative adoption by 2002. These were: concentrates, mineral salts, maize silage, calf pen, milk storage in refrigerator, vaccination of buffalo against foot and mouth disease, ecto parasites treatment, and endo parasites treatment of calves. The innovations which had less than 50% cumulative adoption by 2002, namely artificial inseminations, milk replacement, fodder beet, milking place, and vaccination against Brucellosis.

The curves of cumulative adoption over time (figures 10 to 14) for innovations with 50% to 60% cumulative adoption depict a typical s-shaped with slow initial growth followed by more rapid increase. The expected decline in growth when adoption approaches the maximum level was not

always obvious indicating an ongoing adoption process. AI had a low adoption during the 1980s, increased from 1990 to 2000, and stabilised at 50% in 2001 (Figure 10).

Figure 10. Cumulative adoption of AI

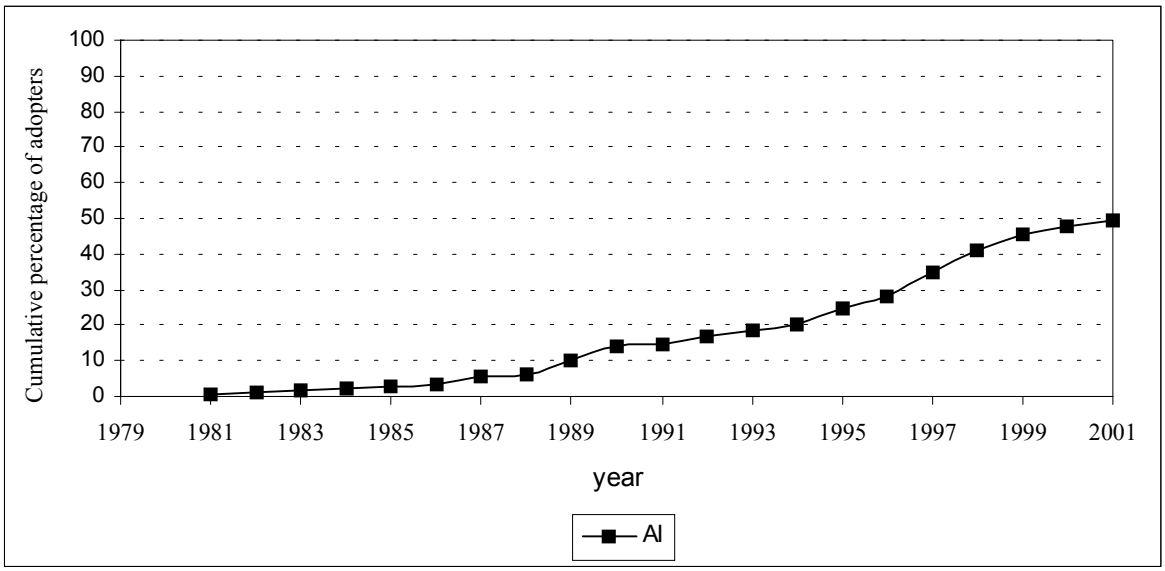


Figure 11 shows the rate of adoption of purchased feed innovations by 2002. Concentrates had a low rate of adoption during (1972-1981), a linear increase until 1997, and then stabilised up to 2001. Mineral salts and milk replacement had a low adoption in 1980s and increased slowly from 1990 to 1994. Since 1994 adoption of mineral salts increased more rapidly than milk replacement.

Figure 11. Cumulative adoption of purchased feed technologies

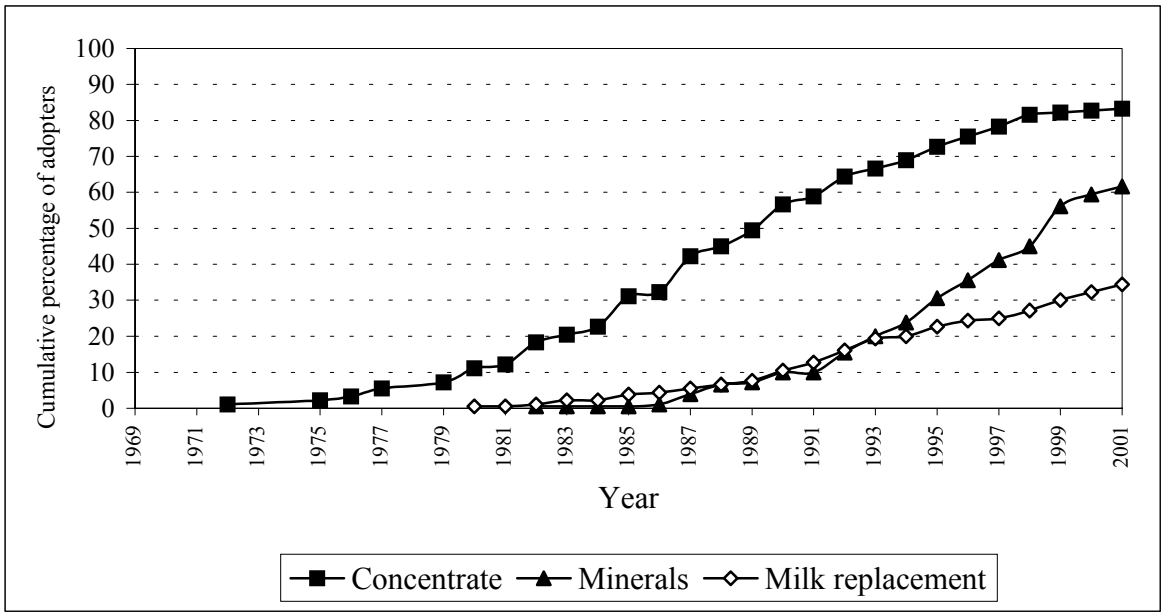


Figure 12 shows the rate of adoption of green fodder innovations by 2002. Maize silage has been adopted since 1990 much more rapidly (> 60%) than adoption of fodder beet (28%).

Figure 11. Cumulative adoption of green fodder technologies

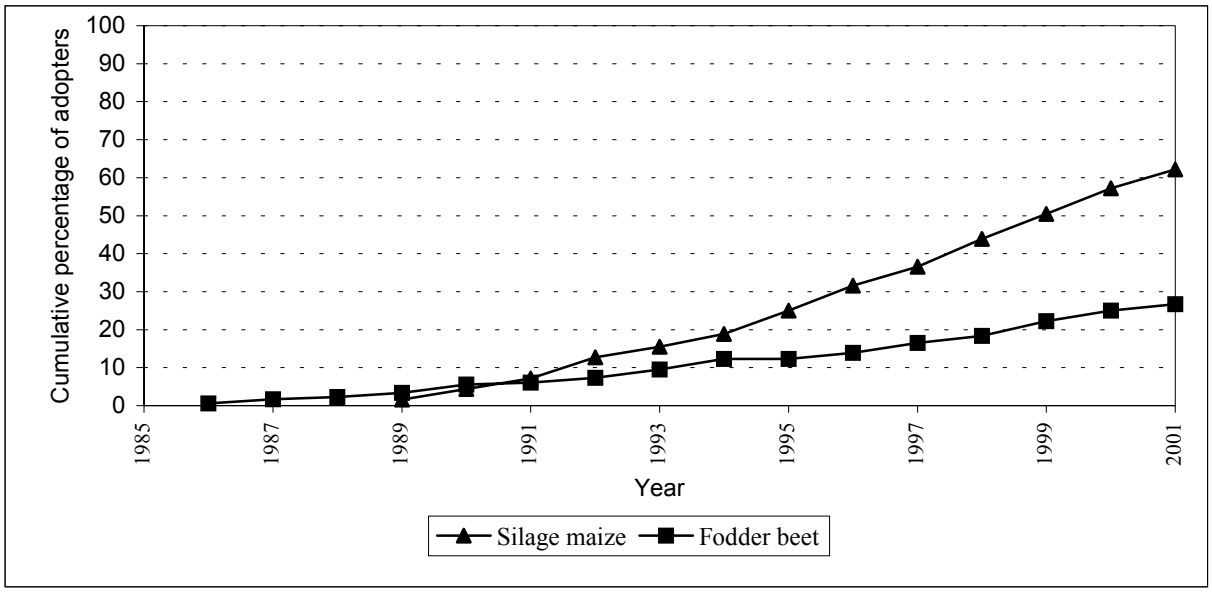


Figure 13 shows the rate of adoption of housing and management innovations by 2002. After a slow start in the 1970s and 1980s, most of the technologies showed an increased rate during the 1990. Calf pen had the fastest and highest cumulative adoption up the current plateau of 80%. Refrigerated milk storage increased at the same pace and slope. While stable hygiene reaches about 60%, the adoption of a milking place is slow and reaches a level of around 40%, only.

Figure 13. Cumulative adoption of housing and management technologies

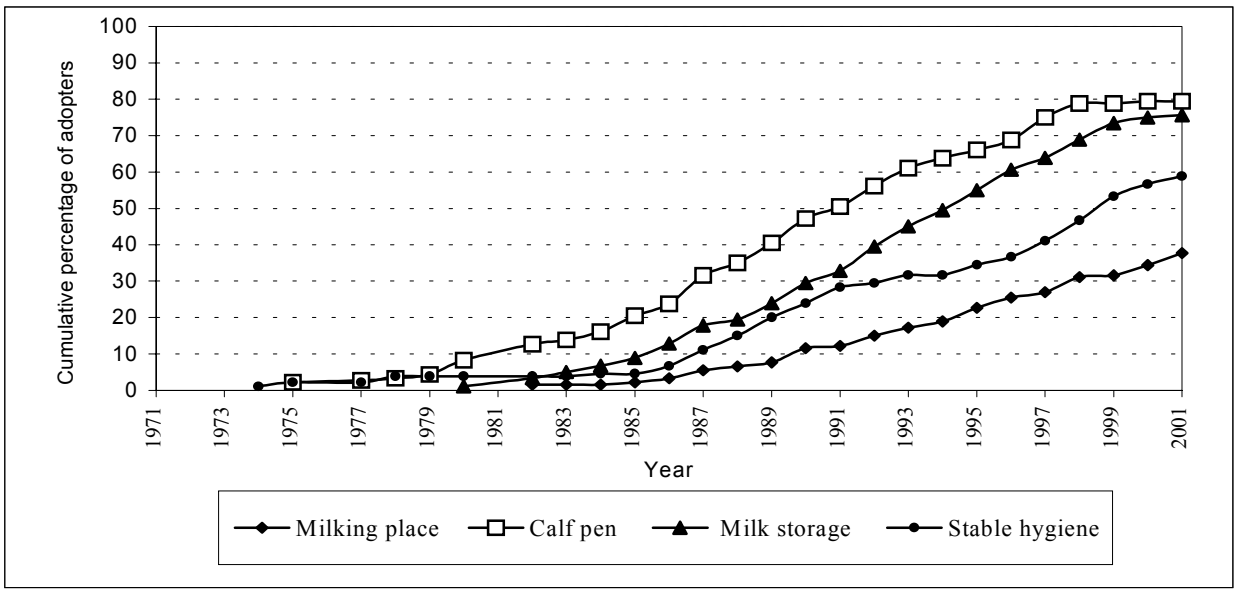
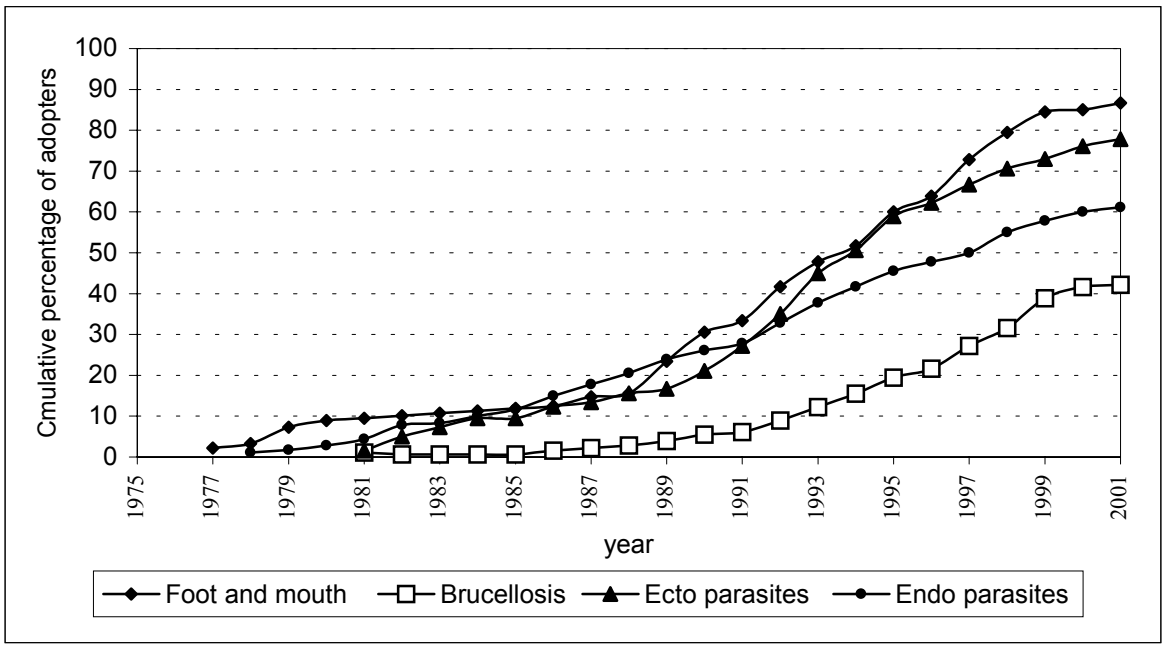


Figure 14 shows the rate of adoption components of health technologies by 2002. The adoption of vaccination against foot and mouth disease and ecto parasites treatment had increased much faster than other health innovations. The adoption of vaccination against foot and mouth disease had increased slowly in 1980s, then jumped between 1990 to 2000 to stabilise thereafter.

The adoption of ecto parasites treatment had stabilised from 1980 to 1984, increased slowly from 1985 to 1995,then increased rapidly up to 1998, stabilised up to 2001. The adoption of endo parasites treatment had had a slow start during 1978 to 1989, sharp increases from 1990 to 2000, and stabilised up to 2002. Adoption of Brucellosis had not increased from 1980 to 1986, increased slowly from 1997 to 1999, and stabilised in 2000.

Figure 14. Cumulative adoption of health technologies component by 2002



5.6.4.3 Speed of adoption

The highest speed of adoption was 4.8 per year for Silage from maize and the lowest speed of adoption was 1.6 per year for milk replacer (Table 57). 5 out of 14 components had annual speeds of over 3 %, namely: maize silage, vaccination against foot and mouth disease, ecto parasites treatment, milk storage in refrigerator, and mineral salts. 5 components had annual speeds of adoption between 2% and 3% namely: Calf pen, concentrates, endo parasite treatment, AI, and stable hygiene. Four components had annual speeds of adoption less than 2%, namely: Milking place, vaccination against Brucellosis, fodder beet, and milk replacement.

A speed of adoption of 4% implies that out of every 100 farmers only four adopted the innovation per year. At such a speed, it would take 25 years (100/4) to fully adopt the innovation. Generally the speed of adoption was low for all innovations, except for maize silage. The implications of this are discussed in section 5.6.6.

5.6 .4.4 Logistic regression analysis for Adoption of buffalo dairy innovations

Factors influencing the adoption of buffalo dairy innovations can be divided into three major categories: 1) Farm circumstances; 2) farmer characteristics; 3) farm characteristics. Factors in the first category include distance to veterinary unit and distance to next milk collection point. The second category includes age of farmers, family size, hired labour, level of education, social participation, cosmopoliteness, mass media exposure, extension contact, veterinarian contact, wealth index, and access to credit. The third category includes farm size, herd size, additional income, and milk sales. A logistic regression analysis was used in this study to test the factors affecting adoption of buffalo dairy innovations. The dependent variables represented adoption/non adoption of 14 innovations. The dependent variable took a value of two for adoption and one for non-adoption. The SPSS statistical package Spsswin 10 was used to run the models. The basic empirical model to be tested is presented below.

$$Zi = a + B_1 Age + B_2 \text{ Household size} + B_3 \text{ Hired labor} + B_4 \text{ Level of education} + B_5 \text{ Social participation} + B_6 \text{ Cosmopoliteness} + B_7 \text{ Mass media exposure} + B_8 \text{ Contact with extension} + B_9 \text{ contact with veterinarian} + B_{10} \text{ Wealth index} + B_{11} \text{ Credit} + B_{12} \text{ Farm size} + B_{13} \text{ Animal unit} + B_{14} \text{ Milk sales} + B_{15} \text{ Additional income} + B_{16} \text{ Distance to veterinary unit} + B_{17} \text{ Distance to next milk collection point.}$$

Where: Zi = Cumulative logistic probability function
a = Constant
$B_1..B_n$ = Regression coefficients

The coefficients of the logistic model used to investigate factors affecting the adoption of AI are shown in Table 54. 76% of adoption of AI is predicted using this model. The factors that significantly ($P < 0.01$) influenced the adoption of AI according to Wald chi-square coefficients are in order of importance: Education, income from milk sales, mass media, farm size, extension contact, additional income, and veterinarian contact. A better education, income from milk sales, veterinarian contact, mass media, and additional income increased the probability of adopting AI while extension devoted to crop production and farm size decreased the probability.

Farmers who are integrated in the milk market are more performance oriented and thus, may favour the use of AI with improved bulls. Access to additional income enables farmers to purchase inputs and encourages farmers to experiment with farming innovations and to deal with risks of new adoptions of buffalo dairy technologies. The positive coefficient of education, mass media, veterinarian contact, milk sales, and additional income, supports the hypotheses 4, 7, 9, 14, and 15 in chapter 4.6.

Table 54. Logistic regression analysis for Adoption of Various buffalo dairy innovations

	AI			Concentrates			Mineral salts		
Variable	B	Wald□	Exp (B)	B	Wald□	Exp (B)	B	Wald□	Exp (B)
Age	-0.001	0.001	0.999	-0.011	0.173	0.989	-0.016	0.734	0.985
Household size	-0.054	0.636	0.948	-0.127	0.987	0.881	-0.097	1.845	0.907
Hired labor	0.530	1.74	1.699	0.810	1.800	2.248	-0.098	0.058	0.906
Education	0.117***	7.531	1.124	0.057	0.786	0.945	0.051	1.363	1.053
Social participation	0.004	0.001	1.004	0.415*	2.512	0.661	0.057	0.223	1.059
Cosmopoliteness	-0.017	0.019	0.983	0.482***	4.458	1.619	0.175	1.833	1.191
Mass media	0.167**	3.558	0.846	-0.067	0.215	0.935	0.139*	2.251	0.870
Extension	-0.204**	2.767	1.227	-0.549***	5.278	0.578	-0.078	0.388	0.925
Veterinarian	0.054*	2.140	1.055	0.171**	7.372	1.187	0.034	0.934	1.035
Wealth index	-0.025	0.301	0.975	0.182**	2.751	1.199	0.006	0.018	1.006
Credit	-0.191	0.234	0.826	-0.693	1.393	0.5	0.715**	3.262	2.044
Farm size	-0.165**	2.847	0.848	0.279	1.075	1.321	0.078	0.563	1.081
Herd size (TLU)	0.109	1.685	1.116	0.274	1.752	1.315	0.104	1.295	1.110
Milk sales	1.345***	6.186	3.838	0.684	1.046	1.981	0.123	0.061	0.884
Additional income	0.635*	2.678	0.530	0.653	1.431	1.921	0.602*	2.617	0.548
Distance to vet. Unit	-0.165	1.658	0.847	-0.134	0.492	0.875	-0.195*	2.064	1.216
Next milk coll. point	-0.167	0.213	0.846	0.117	0.064	1.124	-0.056	0.023	0.945
Constant	-1.682	0.852	0.186	-6.392	4.805	0.002	-0.158	0.008	0.854
-2 log likelihood	195.960			102.32			194.58		
Goodness of fit	183.44			127.47			222.49		
%Correct predicted	76.1			87.2			78.3		
Chi-Square for significance	53.55***			59.88***			46.86***		

Note: *=Significant at p<0.1; **= Significant at p<0.05; ***= Significant at p<0.01. Source: Own estimated

The coefficients obtained from the estimation logistic model are used to investigate factors affecting the adoption of feeding innovations are shown in Table 54 and 55. The model for feeding concentrates to buffaloes predicted 87% of all cases. The factors that significantly influenced ($P < 0.01$) the adoption of concentrates according to Wald chi-square coefficients are in order of importance: veterinarian contact, extension contact, cosmopoliteness, wealth index, and social participation. Veterinarian contact, and the Wealth index, cosmopoliteness, and social participation increased the probability of adopting concentrates, while extension for crop production decreased the probability. The positive coefficient of social participation,

cosmopoliteness, veterinarian contact, and wealth index, supports the hypotheses 5, 6,9, and 10 in chapter 4.6.

The model predicts 78% of adoption of mineral salt to buffaloes. The factors that significantly influenced (P< 0.01) the adoption of mineral salt according to Wald chi-square coefficients are in order of importance: Credit, additional income, mass media, and distance to veterinary unit. Credit, additional income, and mass media increased the probability of adopting mineral salt, while distance to veterinary unit decreased the probability. The positive coefficient of mass media, credit, and additional income supports the hypotheses 7, 12, and 15 in chapter 4.6. Credit and additional income enable the farmers to purchase the mineral salt and thus increase the adoption of mineral salt.

Table 55. Logistic regression analysis for Adoption of Various buffalo dairy innovations

	Milk replacement			Maize silage			Fodder beet		
Variable	B	Wald □	Exp (B)	B	Wald □	Exp (B)	B	Wald □	Exp (B)
Age	-0.033**	2.969	0.968	-0.035**	3.683	0.965	-0.026	1.813	0.974
Household size	0.101*	2.235	1.106	0.034	0.215	1.035	0.128**	3.514	0.880
Hired labor	0.379	0.821	1.461	-0.293	0.55	0.746	0.376	0.780	1.457
Education	-0.013	0.102	0.987	0.021	0.242	0.979	-0.057	1.737	0.944
Social participation	0.099	0.947	1.104	0.067	0.294	1.069	0.068	0.454	1.071
Cosmopoliteness	0.069	0.286	1.071	0.087	0.455	1.091	0.082	0.394	1.086
Mass media	0.066	0.516	1.069	0.04	0.216	1.041	0.027	0.087	1.028
Extension	0.215*	2.574	1.24	0.253***	4.469	1.288	-0.041	0.108	0.96
Veterinarian	0.023	0.414	1.023	0.013	0.135	1.013	-0.046	1.530	0.955
Wealth index	0.118*	6.142	0.888	0.026	0.279	1.027	-0.012	0.078	0.988
Credit	-0.292	0.547	0.747	-0.223	0.303	0.8	0.568*	2.101	1.764
Farm size	0.199**	3.711	0.82	-0.084	0.651	0.92	-0.063	0.428	0.939
Herd size (TLU)	0.096	1.562	1.1	0.095	0.951	1.099	0.152***	4.315	1.164
Milk sales	-0.004	0.000	0.996	0.137	0.074	1.147	0.120	0.042	1.128
Additional income	-0.329	0.794	0.72	0.544*	2.174	0.581	-0.373	0.916	0.689
Distance to vet. Unit	0.021	0.028	1.022	-0.083	0.414	0.92	0.090	0.475	1.094
Next milk coll. point	0.257	0.484	1.293	-0.511*	1.903	0.6	-0.366	0.67	0.694
Constant	-0.504	0.080	0.604	0.57	0.094	1.767	-0.519	0.078	0.595
-2 log likelihood	193.85			190.71			187.26		
Goodness of fit	175.23			169.05			172.51		
%Correct predicted	71.7			68.3			72.2		
Chi-Square for significance	32.88***			41.86***			25.44**		

Note:*=Significant at p<0.1;**= Significant at p<0.05; ***= Significant at p<0.01. Source: Own estimated

The model explains 71% of the adoption of feeding milk replacement to calves. The factors that significantly (P< 0.01) influenced the adoption of milk replacement according to Wald chi-square coefficients are in order of importance are: wealth index, farm size, age of farmers, extension contact, and household size. Wealth index, farm size, extension contact, and family size

increased the probability of adopting milk replacement, while age of farmers decreased the probability. The positive influence of farm size on adoption of milk replacement support the hypotheses that the farmers with larger holdings are more likely adopt lumpy technologies than farmers with smaller holdings. The positive coefficient for household size, extension contact, wealth index, and farm size supports the hypotheses 2, 8,10, and 11 in chapter 4.6.

The model explains 68.3% of the adoption cases for maize silage to buffaloes. The factors that significantly (P< 0.01) influenced the adoption of maize silage according to Wald chi-square coefficients are in order of importance: extension contact, age of farmers, additional income, and distance to next milk collection point. Extension contact and additional income increased the probability of adopting maize silage, while age of farmers and distance to next milk collection point decreased the probability. The positive coefficient extension contact, and additional income support the hypothesis 8 and 15 in chapter 4.6.

The model predicts 72.2% of adoption of fodder beet production. The factors that significantly influenced (P< 0.01) the adoption of fodder beet production according to Wald chi-square coefficients are in order of importance: Herd size (TLU), family size, and credit. Herd size, family size, and credit, increased the probability of adopting fodder beet production. The positive coefficient of herd size, family size, credit supported the hypotheses 2, 12 and 13 in chapter 4.6.

The coefficients of the logistic model used to investigate factors affecting the adoption of housing and management innovations are shown in Table 56 and 57.

The model explains 72.2% of the adoption of milking place. The factors that significantly influenced (P< 0.01) the adoption of milking place according to Wald chi-square coefficients are in order of importance: Hired labour, herd size, and contact with veterinarian. Herd size and Veterinarian contact increased the probability of adopting milking place, while hired Labour decreased the probability. The positive coefficients of veterinarian contact, and herd size support the hypotheses 9, and 13 in chapter 4.6. Contact with veterinarian enhances the farmers' access to information and thus increased the probability of adopting milking place. A larger herd size requires the additional installation milking place.

The model explains 78% of the adoption of calf pen. The factors that significantly (P< 0.01) influenced the adoption of a calf pen according to Wald chi-square coefficients are in order of

importance: social participation, age of farmers, household size, and income from milk sales. Social participation, and family size increased the probability of adopting calf pen, while age of farmers and income from milk sales decreased the probability. The positive coefficients of household size and social participation support the hypotheses 2,5 and 13 in chapter 4.6.

Table 56. Logistic regression analysis for Adoption of Various buffalo dairy innovations

	Milking place			Calf pen			Storage milk		
Variable	B	Wald □	Exp (B)	B	Wald □	Exp (B)	B	Wald □	Exp (B)
Age	0.000	0.000	1	-0.033*	2.387	0.968	0.033	1.896	1.034
Household size	-0.082	1.746	0.921	0.129*	2.024	1.138	-0.250***	6.677	0.778
Hired labor	-0.637*	2.623	1.89	0.176	0.157	1.192	0.110	0.046	1.116
Education	0.009	0.054	1.009	0.012	0.054	1.012	0.094*	2.691	0.91
Social participation	-0.062	0.406	0.94	0.223*	2.416	1.25	0.19	0.821	1.209
Cosmopoliteness	0.126	1.161	1.134	0.051	0.129	1.053	0.417***	4.730	1.517
Mass media	-0.043	0.255	0.957	-0.019	0.037	0.981	0.151	1.580	0.86
Extension	-0.144	1.534	0.866	0.042	0.097	1.043	-0.258*	1.990	0.773
Veterinarian	0.046*	1.897	1.047	0.044	1.048	1.045	0.005	0.012	1.005
Wealth index	-0.007	0.028	0.993	0.036	0.344	1.037	0.045	0.401	1.046
Credit	0.311	0.723	1.364	0.369	0.595	1.447	-0.33	0.399	0.719
Farm size	-0.066	0.574	0.936	-0.083	0.565	0.921	0.167	0.787	1.182
Herd size (TLU)	0.113*	2.562	1.119	-0.06	0.357	0.941	0.212*	1.922	1.236
Milk sales	0.217	0.176	1.242	-0.717*	1.385	0.488	0.734	1.736	2.083
Additional income	-0.33	0.86	0.719	-0.826	3.624	0.438	0.068	0.02	1.071
Distance to vet. Unit	0.139	1.309	1.149	-0.018	0.014	0.982	-0.502	8.605	0.606
Next milk coll. point	0.002	0.000	1.002	-0.331	0.706	0.718	-0.248***	0.308	1.282
Constant	-2.867*	2.705	0.057	2.281	1.051	9.791	-2.313	0.998	0.099
-2 log likelihood	212.37			158.07			126.34		
Goodness of fit	184.39			158.82			117.73		
%Correct predicted	72.2			78.3			80.6		
Chi-Square for significance	27.26**			24.82**			73.87***		

Note: *=Significant at p<0.1; **= Significant at p<0.05; ***= Significant at p<0.01. Source: Own estimated

The model explains 80% of the adoption of milk storage in refrigerator. The factors that significantly (P< 0.01) influenced the adoption of milk storage in a refrigerator according to Wald chi-square coefficients are in order of importance: distance to next milk collection, household size, cosmopoliteness, education, extension contact, and herd size. Adoption of milk storage increases by family size, cosmopoliteness, education, and herd size, while extension contact, and distance to next milk collection point decreased the probability. The positive coefficient of education, cosmopoliteness, and herd size supported the hypotheses 4,6 and 13 in chapter 4.6, while the negative coefficient of distance to next milk collection supported the hypotheses 16 in chapter 4.6.

Farmers with higher level of education showed a higher tendency to adopt innovation than those with a low level of education. Farmers with higher contacts outside of the village especially urban centers had adopted innovation more than those with low level of general of awareness.

Predictions regarding the adoption of stable hygiene are significant and apply in 73% of all cases. The factors that significantly (P< 0.01) influenced the adoption of stable hygiene according to the Wald chi-square coefficients are in order of importance: social participation, age of farmers, farm size, and education. Social participation, education, and farm size increased the probability of adopting stable hygiene, while age of farmers decreased the probability. The positive coefficient of social participation, education, and farm size supported the hypotheses 4, 5, and 11 in chapter 4.6. Farmers with larger farms were more likely to adopt than those with small farms. Participation in social and organizational activities was expected to have an indirect influence on the adoption behavior of farmers. It links the individual to the larger society and exposes him to a variety of ideas. This exposure makes him positively predisposed towards innovative ideas and practices.

Table 57. Logistic regression analysis for Adoption of Various buffalo dairy innovations

	Stable hygiene			Vaccination against FMD			Vacc against Brucellosis		
Variable	B	Wald □	Exp (B)	B	Wald □	Exp (B)	B	Wald □	Exp (B)
Age	-0.034**	3.507	0.967	-0.026	0.992	0.975	-0.005	0.06	0.995
Household size	-0.067	1.084	0.935	0.016	0.022	1.016	-0.072	1.087	0.931
Hired labor	0.269	0.475	1.309	0.399	0.414	1.491	0.423	1.064	1.527
Education	0.066*	2.453	0.936	-0.044	0.488	0.957	0.027	0.405	1.028
Social participation	0.249***	4.625	1.282	-0.166	0.472	0.847	0.143	1.657	1.153
Cosmopoliteness	0.141	1.252	1.151	0.196	0.849	1.217	0.059	0.222	1.061
Mass media	0.083	0.894	0.921	0.186	1.957	0.83	-0.079	0.812	0.924
Extension	- 0.043	0.133	1.044	-0.024	0.015	0.977	- 0.101	0.660	1.107
Veterinarian	-0.039	1.263	0.962	0.170***	7.605	1.185	-0.003	0.006	0.997
Wealth index	0.019	0.171	0.981	-0.095	1.519	0.91	-0.038	0.637	0.962
Credit	0.256	0.452	1.292	0.267	0.203	1.306	0.157	0.156	1.17
Farm size	0.204**	3.036	1.226	0.362	1.875	1.436	-0.204**	3.601	0.816
Herd size (TLU)	0.018	0.048	1.018	0.006	0.001	1.006	0.209***	5.393	1.233
Milk sales	0.573	1.345	1.773	1.058**	2.724	2.88	-0.182	0.117	0.833
Additional income	-0.42	1.392	0.657	-0.046	0.008	0.955	-0.037	0.009	0.964
Distance to vet. Unit	-0.03	0.053	0.971	-0.282*	2.098	0.754	-0.466***	8.874	0.627
Next milk coll. point	-0.378	1.097	0.685	-0.721*	2.329	0.486	0.049	0.017	1.05
Constant	1.076	0.368	2.932	1.217	0.188	3.378	-0.306	0.025	0.736
-2 log likelihood	201.35			105.99			189.34		
Goodness of fit	187.96			212.71			174.56		
%Correct predicted	73.3			87.2			75.0		
Chi-Square for significance	42.46***			35.37***			51.23***		

Note: *=Significant at p<0.1;**= Significant at p<0.05; ***= Significant at p<0.01. Source: Own estimated

The coefficients derived from the logistic model used to investigate factors affecting the adoption of health innovations are listed in Table 57 and 58. The model explains 87% of the adoption of vaccination against FMD. The factors that significantly (P< 0.01) influenced the adoption of vaccination against FMD according to the Wald chi-square coefficients are in order of importance: contact with veterinarian, income from milk sales, distance to next milk collection point, and distance to veterinary unit. The contact with veterinarian, and income from milk sales increased the probability of adopting vaccination against FMD, while distance to veterinary unit, and to the next milk collection point decreased the probability. The positive coefficient of veterinarian contact, and milk sales supports the hypotheses 9 and 14 in chapter 4.6. The contact with veterinarian has a positive influence on the level of consciousness of farmers. The negative coefficient of distance to veterinary unit and next milk collection point supports the hypothesis 16 in chapter 4.6.

Table 58. Logistic regression analysis for Adoption of Various buffalo dairy innovations

Variable	Ecto parasites			Endo parasites		
	B	Wald	Exp (B)	B	Wald	Exp (B)
Age	-0.021	0.999	0.979	-0.009	0.296	0.991
Household size	0.071	0.701	1.074	-0.042	0.4	0.959
Hired labor	-0.03	0.004	0.971	-0.653***	2.742	0.521
Education	0.076*	2.276	1.079	0.037	0.830	1.038
Social participation	0.102	0.443	1.107	-0.173*	2.299	0.841
Cosmopoliteness	0.406***	5.998	1.501	0.267***	4.328	1.306
Mass media	0.193**	3.204	0.825	-0.024	0.077	0.976
Extension	-0.190	1.622	1.209	-0.07	0.344	1.073
Veterinarian	-0.002	0.002	0.998	0.035	1.036	1.035
Wealth index	0.135***	5.811	0.873	0.04	0.86	0.961
Credit	0.959**	3.595	2.609	0.189	0.246	1.208
Farm size	-0.115	0.956	0.891	0.074	0.532	1.077
Animal unit	0.088	0.587	1.092	0.102	1.500	1.107
Milk sales	1.502***	7.051	4.491	0.757*	2.470	2.131
Additional income	0.185	0.186	1.204	-0.147	0.168	0.864
Distance to vet. Unit	-0.180	1.381	0.835	-0.092	0.518	0.912
Next milk coll. point	-0.219	0.264	0.803	0.333	0.874	1.395
Constant	-2.147	1.045	0.117	-1.952	1.252	0.142
-2 log likelihood	148.86			208.80		
Goodness of fit	205.019			174.006		
%Correct predicted	82.2			67.8		
Chi-Square for significance	41.832***			31.768***		

Note:*=Significant at p<0.1;**= Significant at p<0.05; ***= Significant at p<0.01. Source: Own estimated

The model explains 75% of the adoption of vaccination against Brucellosis. The factors that significantly (P< 0.01) influenced the adoption of vaccination against Brucellosis according to the Wald chi-square coefficients are in order of importance: distance to veterinary unit, herd size, and farm size. Herd size increased the probability of adopting vaccination against Brucellosis, while

farm size, and distance to veterinary unit, decreased the probability of adopting. Greater distance to veterinary services may make farmers hesitate to adopt technologies that require information and advice by the veterinarian. The positive coefficient of herd size and the negative coefficient of distance to veterinary unit support the hypotheses 13, 16 in chapter 4.6.

The model explains 82% of the adoption of ecto parasite treatment. The factors that significantly ($P< 0.01$) influenced the adoption of ecto parasite treatment. The factors that contribute to adoption of ecto parasite treatment according to the Wald chi-square coefficients are in order of importance: income from milk sales, cosmopoliteness, wealth index, credit, mass media, and education. Income from milk sales, cosmopoliteness, wealth index, credit, mass media, and education. There were strong indications that milk sales have an important role to play in overcoming liquidity constraints and in the use of improved technology and subsequently increased yield. The positive coefficient of education, cosmopoliteness, mass media, wealth index, credit, and milk sales supported the hypotheses 4, 6, 7, 10, 12, and 14 in chapter 4.6.

The model predicts 67% of the adoption of endo parasites treatment. The factors that significantly ($P< 0.01$) influenced the adoption of endo parasite treatment according to the Wald chi-square coefficients are in order of importance: cosmopoliteness, hired labour, milk sales, and social participation. Income from milk sales, and cosmopoliteness increased the probability of adopting endo parasite treatment, while social participation, and hired labour decreased the probability. The positive coefficient of cosmopoliteness, and income from milk sales supported the hypotheses while the negative coefficient of social participation did not support hypotheses 6, and 14 in chapter 4.6.

5.6.4.5 Reasons for non- adoption and discontinuation of innovations

Reasons for non- adoption and discontinuation of innovations are summarized in Table 59. The main reasons for non- adoption and discontinuation of AI for 57% of farmers in Ashmoun are distance to artificial insemination (AI) center and preference for natural service while only 44% of Shebeen non-adopters appreciated the above reasons. Moreover, most of the large farmers are maintaining one bull for breeding purposes, which made them prefer natural service rather than going to artificial insemination.

Table 59. Reasons for non- adoption and discontinuation of innovations and their relative

Reasons	Whole sample				Shebeen El-Kom				Ashmoun			
	Number and percentage of farmers											
	I	II	III	%	I	II	III	%	I	II	III	%
Artificial inseminations												
1. Absence of AI center in the village	15	9	1	19	10	5	-	22	5	4	1	15
2. Distance of AI center	11	8	4	17	4	2	1	10	7	6	3	24
3. Lack of knowledge of AI.	10	6	5	16	5	3	3	16	5	3	2	15
4. Preference to natural service	26	17	2	34	11	10	2	34	15	7	-	33
5. Non-availability of AI facilities	9	4	6	14	4	1	6	16	5	3	-	13
Concentrates												
1. Expensiveness of concentrates	9	3	4	47	5	1	1	52	4	2	3	39
2.Habit of feeding the animals with the local ingredients due to low purchasing power	7	7	-	53	3	2	-	48	4	5	-	61
Mineral salts												
1. Lack of extension service	20	15	-	40	8	12	-	43	12	3	-	37
2. Expensiveness	25	15	8	55	12	5	8	53	13	10	-	56
3. Non-availability of minerals	3	1	1	6	1	1	-	4	2	-	1	7
Milk replacement												
1. Suckling is better than milk replacement	25	6	-	24	18	2	-	30	7	4	-	18
2. Too low growth rate	10	5	-	12	5	2	-	11	5	3	-	13
3. Non-availability of milk replacement	12	4	1	13	7	2	-	14	5	2	1	13
4. Early sell of calves	50	2	2	43	23	1	-	36	27	1	2	49
5. Lack of knowledge of milk replacement	6	3	1	8	3	3	-	9	3	-	1	7
Maize silage												
1.Lack of knowledge in preparing silage	28	6	1	50	16	4	1	51	12	2	-	48
2. Herd size is too small	15	7	3	36	10	5	1	39	5	2	2	31
3.Lack of money	5	3	2	14	2	2	-	9	3	1	2	20
Fodder beet												
1.Size of landholding is too small	27	14	-	27	17	2	-	25	10	12	-	29
2.Non- availability of seeds	26	15	1	28	15	6	1	29	11	9	-	27
3.Lack of knowledge	30	10	1	27	13	2	1	21	17	8	-	33
4. Fodder beet growing not suitable for agricultural cycle	10	16	2	18	10	8	2	26	-	8	-	11
Milking place												
1. Restriction of legislation for building	71	24	1	79	30	9	1	70	41	15	-	88
2. Herd size is too small	11	4	-	12	4	3	-	12	7	1	-	13
3. Non-availability of facilities	9	-	1	8	9	-	1	18	-	-	-	0
Calf pen												
1. Size of landholding is too small	12	9	2	41	8	6	1	47	4	3	1	33
2. Early sell of calves	25	7	1	59	16	-	1	53	9	7	-	67
Milk storage in refrigerator												
1. Non-availability of facilities	13	8	-	28	8	4	-	31	5	4	-	25
2. Saling fresh milk every day	35	15	5	72	16	8	3	69	19	7	2	76

Source: Own Survey, *I, II, III = Farmers ranking of importance of the Reasons for non -adoption and

About 61% of non-adopters in the Ashmoun District said that the main reasons for not using concentrate feed stuffs is their low purchasing power while 52% of non-adopters in the Shebeen

District indicated that cost of concentrates is the main reason for non-adoption and discontinuation of feeding concentrates. The main reasons for non-adoption and discontinuation of mineral salt mentioned by more than 90% of non- adopters in both Districts are associated with lack of extension service on dairy production and cost of mineral salt. Similar reasons are given for non-adoption and discontinuation of milk replacement. The main reasons for not using silage mentioned by 85% of non-adopters were related to lack of knowledge in preparing silage and their small herd size.

The probable reasons for non-adopting feeding innovations could be it high cost of the high cost of feeding, exploitation by private vendors due to marketing problems in flush seasons, and lack of sufficient resources and low social economic status for getting loans.

Table 59. Continued

Reasons	Whole sample				Shebeen El-Kom				Ashmoun			
	Number and percentage of farmers											
	I	II	III	%	I	II	III	%	I	II	III	%
Stable hygiene												
1. Absence of insects	18	6	4	34	6	4	2	31	12	2	2	37
2. Costly	8	2	1	13	3	2	-	13	5	-	1	14
3. Absence of veterinary unit	7	4	5	20	4	1	3	21	3	3	2	19
4. Lack of knowledge	10	6	4	24	4	3	2	23	6	3	2	26
5. Afraid of animal poisoning	3	2	2	9	3	2	-	13	-	-	2	5
Vaccination against foot & mouth disease												
1. Distance of veterinary unit	15	8	-	44	7	5	-	44	8	3	-	44
2. Absence of disease	11	4	2	33	5	2	1	30	6	2	1	36
3. Lack of veterinary service	8	3	1	23	4	3	-	26	4	-	1	20
Vaccination against Brucellosis												
1. Absence of disease	30	10	6	36	12	6	2	31	18	4	4	42
2. Recommendations given by the veterinarians are not enough.	24	9	6	31	13	6	6	38	11	3	-	23
3. Distance of veterinary unit	23	12	7	33	10	5	5	31	13	7	2	35
Ecto parasites treatment												
1. Absence of parasites	10	5	6	47	7	3	5	50	3	2	1	40
2. Non –availability of Ivomac	8	3	4	33	6	-	4	33	2	3	-	33
3. Disposal parasites by hand	5	3	1	20	2	2	1	17	3	1	-	27
Endo parasites treatment												
1. Availability of alternatives	50	15	5	76	30	10	3	81	30	5	2	76
2. Buffaloes are healthy	8	10	4	24	2	4	4	19	6	6	-	24

Source: Own Survey, *I, II, III = Farmers ranking of importance of the Reasons for non -adoption and discontinuation of buffalo dairy innovations, (I = most important).

The current building legislation does restrict farmers to make farm constructions. This was the main reason for non-adoption of milking place felt by most of 88% of non-adopters in Ashmoun

District and 70% of non-adopters in Shebeen District. Most of non-adopters in both Districts indicated that calves are sold after early weaning is the main reason for non-adoption and discontinuation of calf pen. Most non-adopters gave similar reasons for non-adoption and discontinuation of milk storage. About 60% of non-adopters related reasons for non-adoption and discontinuation of stable hygiene with absence of insects and lack of knowledge.

The main reasons for non-adoption and discontinuation of vaccinating buffaloes against foot and mouth and Brucellosis diseases were absence of diseases and far distance to the veterinary unit. Obviously, most non-adopters in the two Districts reported that the main reasons for non-adoption and discontinuation using ecto parasites treatment were absence of parasites and non-availability of Ivomac while the main reason for non-adoption and discontinuation of endo parasites treatment was availability of alternatives.

5.6.5 Influence of characteristics of innovation on adoption and diffusion

The influence of characteristics of innovation on adoption parameters was analyzed by using linear regression analysis. The regression models were obtained by using combinations of relative investment and relative complexity as explanatory variables for the adoption parameters. The basic models are presented as follows.

$AR_{2002} = B_0 + B_1 time + B_2 \text{ relative complexity} + B_3 \text{ relative investment} + e$ (12)

$Speed_{2002} = B_0 + B_1 time + B_2 relative\ complexity + B_3 relative\ investment + e$ (13)

Where: time = Number of years elapsed between start of diffusion and 2002.

AR_{2002} = Rate of adoption by 2002

$Speed_{2002}$ = Speed to AR_{2002}

B_0 = Constant

$B_{1...n}$ = Regression coefficient for variable 1…2

The results of the models for current rate and speed of adoption (AR_{2002}) are shown in Table 60. The two characteristics of innovations (relative investment and relative complexity with time) explained 76% of the rate of adoption and 63% of the speed of adoption. The adjusted R^2 was significant at < 0.01.

The complexity as the one explanatory variable explained 66% of the rate of adoption and 51% of the speed of adoption; the relative complexity was significant related to the rate and speed of adoption as hypothesized.

Table 60. Influence of innovations characteristics on current rate and speed of adoption

Constant	Time	Relative complexity	Relative investment	Adjusted R^2
AR2002	b values(t values)	b values(t values)	b values(t values)	
43.90(2.37)	1.45** (1.94		-6.71***(-3.88)	0.632***
54.67(2.59)	1.58***(2.23)	-16.15***(-4.24)		0.669***
53.65 (3.54)	1.34** (2.22)	-10.68***(-2.71)	-4.024***(-2.373)	0.767***
Speed 2002				
5.39(5.29)	-0.08** (-1.97)		-0.35***(-3.66)	0.492***
5.46(5.45)	-0.07* (-1.85)	-0.82***(-3.82)		0.514***
5.88(6.62)	-0.08***(-2.47)	-0.53***(-2.31)	-0.21**(2.16)	0.636***

Source: own calculations. *Significant at 10%, ** Significant at 5, *** Significant at 1%, attributes characteristics

Also the relative investment explained 63% of the rate of adoption and 49% of the speed of adoption. This model was significant at p<1%. The relative investment was significant related to the rate and speed of adoption as hypothesized.

5.6.6 Discussion of the adoption study

The adoption study was conducted to analyse the influence of farming circumstances, farm characteristics and farmer's characteristics on adoption of buffalo dairy innovations. It describes the dairy farming system in Shebeen El-Kom and Ashmoun Districts of Menoufia Governorate. It statistically analyses how they have influenced farmer's decisions in adopting dairy innovations, and analyses the influence of characteristics of innovations on rate and speed of adoption. With regard to the farming circumstances, the infrastructure between the two districts differs greatly. Analysis of local infrastructure in the study areas showed that most farmers have problems in getting access to farm input, information, roads, extension, buffalo vaccination, credit and support services. Farmers in the Ashmoun district have generally to cover greater distances to the District town, veterinary unit, and next milk collection point. The milk-marketing infrastructure is accessible to most farmers. 79% of the farmers are marketing milk. The highest proportion of farmers (65 %) was between 41 and 60 years. Gender analysis indicated that farmers in both Districts are almost males. Average family size in the Ashmoun District was slightly larger than in the Shebeen District. Farmers in the Ashmoun District were on average less educated than farmers in the Shebeen El-Kom District. Farmers in the Ashmoun District participated in more organizations than farmers in Shebeen El-Kom district. Farmers in Ashmoun District were more cosmopolite than those in Shebeen District. More than 80% of farmers were falling in the low and medium levels of mass media exposure. The extension activities regarding dairy production

technologies were generally very weak. The highest mean value for Farmers' access to extension services was found in Ashmoun District. The highest mean value for Farmers' access to veterinary services was found in Ashmoun District. Farmers in the Ashmoun district were wealthier than farmers in the Shebeen El-Kom district. Analysis of data showed that credit provided to farmers was for crop production inputs particularly for purchase of fertilizers and seeds. The main constraint for using credit was the high interest rate. Farmers in the Shebeen District had more access to credit than those in the Ashmoun District. Analysis of farm characteristics showed that farmers in Shebeen districts were resource-poor small-scale farmers. The Ashmoun farmers had a larger average farm size and area under cultivation than Shebeen farmers. Analysis of land use and pattern showed that in both Districts, the biggest area of the land has allocated to animal feed followed by cash crops and food crops, respectively. The contribution of livestock products to the gross farm income was 68.1%. Ashmoun farmers had more livestock than the Shebeen farmers. The high contribution of livestock to the gross output among households in the study area reflects the importance of integrating livestock in farming system. Livestock keeping is primarily carried out in the home compounds in very small numbers: the majority of farmers have one or two buffaloes or cows, some farmers have three, but only a majority have more than three buffaloes. Buffalo, being the most important animal, constituted the herd in the study area. Calves are sold after early weaning indicating a low cost-benefit rate for rearing youngstock. This may be related to the serious shortage of feed in the area, which only allows two or three buffaloes to be fed per farm. The analysis of performance of the buffaloes indicated that average milk yield, and the lactation periods of buffaloes in the Ashmoun District were higher than those in Shebeen District. The difference was basically a function of better nutrition in the Ashmoun District. The main objective of keeping buffaloes in the study areas was to obtain income and provide food for household. The majority of farmers in both districts said that they produced milk as a source of income and for household consumption.

Personal sources of information about innovations are more important than impersonal sources. 89% of farmers were using personal communication as a source of information about overall innovations compared to 11% of farmers, who mainly used impersonal communication.

Assessment of technology adoption showed that farmers in the Ashmoun District are more innovative than farmers in Shebeen District. The rate of adoption of all innovations in Ashmoun District was higher than in Shebeen District.

The reproduction innovation such as AI was poorly adopted and had a low speed of adoption due to unreliability of AI service, bad roads, and lack of veterinary and extension services.

Animal feed innovations were highly adopted except milk replacer and fodder beet. Concentrates were highly adopted and had the highest speed of adoption due to its positive effect on milk production. Maize silage was highly adopted, had the highest speed of adoption because of its high land productivity for small- scale farmers since cost of land is the greatest constraints. Maize allows even the farmer with a small piece of land to own a buffalo. Mineral salts improve milk production but it was not very highly adopted and the speed of adoption was not very high.

The adoption of housing and management innovations were highly adopted, except milking place. The low adoption and low speed of adoption of milking place supports the hypothesis that small-scale, resource-poor farmers hesitate to adopt innovations that require lumpy capital outlay and provide only a low utility to farmers.

Animal health innovations were also highly adopted and high speeds of adoption except Brucellosis. Because they ensure that the buffalo remains healthy. In particular most farmers in the study areas adopted Vaccination against FMD, and ecto parasite treatment. They were easy to apply and have a positive effect on major problems facing the farmers: the risk of losing a buffalo. This leads to a perception of high utility when compared with traditional technologies such as hand removing of ticks on buffaloes. The low rate and speed of adoption of vaccination against Brucellosis is related to the closure of many buffalo vaccination centers in the area, far distance of veterinary unit and low importance of the disease.

In 2002, more than 30 years after the first introduction the speed of adoption of some technologies remains low. This implies that the innovations were either not appropriate (a research problem), or they were not diffused well enough in the area (an extension problem) or there were other factors outside research and extension that were impeding adoption such as unfavorable policies. It may also have been caused by combination of the three factors.

Most innovations seem to be appropriate for the region and types of farmers. The characteristics of innovations explained 76% and 63% of the rate and speed of adoption by 2002. These characteristics still had the greatest influence on adoption of innovations in the regression model.

The logistic analysis showed that the hypotheses developed in chapter 4 could only partly be supported.

The age of farmers had negatively and significantly influenced the adoption of milk replacement, maize silage, calf pen, and stable hygiene. The hypothesis that younger farmers are more receptive to new innovations and bear more risks than their older farmers counterparts in the study, as no significant effect of age on the adoption of the most of various buffalo dairy production innovations was observed. The results were in agreement with the findings of several other authors (SINGH et al., 1993;ADESINA and BAIDU- Forson, 1995, Bali, 1996; WAITHAKA, 1998; JABBAR et al., 1998; BULALE, 2000; EL- MELEGI, 2000; EL-GANNAM, 2000; GOSWAMI et al., 2001; SALAMA, 2001).

The effect of household size on the adoption of buffalo dairy production innovations was positive and significant for fodder beet and calf pen and milk replacement. Positive and significant effects of household size have also been reported by AL-HABAL (1990), SINGH and SHARMA (1995), EL-ABASY (1995), ZELLER et al. (1998), GETAHUN et al. (2000), AL-SAKRAN (2001), and FOLTZ and CHANG (2002). In more recent studies in Egypt BALI (1996) and EL-MELEGI (2000) found positive and significant effect of household size on the adoption of improved breeding and management technologies in dairy cattle. KEBEDE et al. (1990), however reports on the adoption of single-ox, pesticide, and fertiliser technologies, and showed mixed effects of household size on adoption rates. Household size significantly influenced the adoption of pesticide but had no influence on single-ox and fertiliser technologies. In a more recent study the adoption of improved dairy technologies in Kenya BATZ, (1999) found a negative and significant effect of household size on bucket feeding. The author also found significant and positive relationship between household size and a spraying and dipping of animals.

Labour availability affects farmers` decisions about new agricultural technologies, agricultural practices and inputs. Labour measured in terms of Labour allocated to crop production, exerted a significant influence on the adoption of milking place and endo parasites treatment. The relationship between labour devoted to crop production and the adoption of milking place and endo parasites treatment was negative. The more labour was allocated to crop production, the less likely were the adoption of milking place and endo parasites treatment, suggesting labour scarcity in the area. Labour scarcity with regard to endo parasites treatment was mainly related to the distance involved in buying medications from towns, for which adult labour could not be

substituted. Milking place construction was also a task that only adults can accomplish, thus showing some competition for labour between crop production and dairy rearing technologies in the area. Significant effects of labour on the adoption of crop and dairy production technologies have also been reported by YASSA (1983), EL-MAGHAWRY (1994), BATZ (1999), and BULALE (2000). However WAITHAKA (1998), EL-MELEGI (2000), HASSANIEN (2000) MUSSEI et al. (2001), MIZHER (2002), did not observe an effect of labour on the adoption of crop and dairy production technologies.

The relationship between the adoption of buffalo dairy production innovations and level of education of farmers was positive for most of the innovations and significant for AI, ecto parasite treatment, stable hygiene, and milk storage in refrigerator. The higher the level of education, the higher will likely be adoption of buffalo dairy production innovations. Various authors have found a positive and significant relationship between adoption of technologies and educational levels and agreed well with the current findings (MAHMOUD, 1994; SOROUR, 1996; EL-TANTAWY 1998; LAPAR and PANDEY 1999; EL-GANNAM, 2000; FOLTZ and CHANG, 2002). In a study the adoption of improved dairy technologies in Kenya, BATZ (1999) found an positive and significant effect of education on cowshed and milking place. Positive but non-significant effects of formal education on adoption of technologies have also reported by MADHUKAR and RAM (1996), WAITHAKA (1998), HAFZ and ANWAR (1999), GETAHUN et al. (2000) and SHIBAH et al. (2002).

The relationship between the adoption of buffalo dairy production innovations and social participation was positive for most of the innovations and significant for concentrates, calf pen, cleaning stable and endo parasite treatment. The results were consistent with the findings of several other authors (SINGH et al., 1993; MAHMOUD, 1994; EL-HABAL, 1995; BALI, 1996; EL-GHAMRINI, 1998; SALAMA, 2001; LAPAR and PANDEY, 1999; and HASSANIEN, 2000). Non- significant effects of social participation on the adoption of technologies had also been reported by ABDEL MAKSOUD and ELNASSAR (1987), BARSOUM (1988), Soma and BALI (1999), and GETAHUN et al. (2000).

The relationship between the adoption of buffalo dairy production innovations and cosmopoliteness was positive for most of the innovations and significant for concentrates, milk storage in refrigerator, endo parasite treatment, and ecto parasite treatment. The findings regarding the effect of cosmopoliteness on the adoption of buffalo dairy production innovations

are in agreement with results of EL-ABASY (1995), EL-GHAMRINI (1996), ABDEL-GUID (1998), Soma and Bali (1999), SALAMA (2001), GOSWAMI et al. (2001). On the other hand non-significant effects of cosmopoliteness on the adoption of technologies were reported by BARSOUM (1988), AHMED (1994), GAD-AL-RAB and SHALABY (1997) HOSSEIN (1998), and SHIBAH et al. (2002).

The effect of mass media exposure on most of the adoption of buffalo dairy production innovations were significant with a positive relationship for AI, mineral salts, and ecto parasite treatment. The results were consistent with the findings of MAHMOUD (1994), SINGH and SHARMA (1995), SHAHIN (1995), MADHUKAR and RAM (1996), BALI (1996), SAHA et al. (1997), GOSWAMI et al. (2000), and ABD EL-RAZEK (2002). SINGH et al. (1993) observed non-significant effects of the mass media on the adoption of dairy technologies.

The effects of extension, measured in terms of whether farmers were visited or not, did not influence the uptake of dairy production technologies because the extension activities regarding dairy production technologies were generally very weak. The implementation of extension efforts were directed to improve crop production levels especially cotton, maize, and wheat. Effects of extension on buffalo dairy production were negative but not significant. In the study area extension activities on animal production was non-existent. In Egypt, there is a tendency of considering livestock issues secondary to crop production. These results are consistent with various other reports from Egypt (EL-HABAL and OSMAN, 1989; AHMED, 1994, SHAHIN, 1995; SOROUR, 1996; EL-GHAMRINI, 1998; and SALAMA, 2001). While Bulale (2000) observed non-significant effects of extension on the dairy production technologies in Ethiopia, EL-HABAL (1990), MAHMOUD (1994), BALI (1996) HAFZ and ANWAR (1999), EL-MEKAWY (1996), MUSSEI et al. (2001) found a positive and significant influence of extension on dairy production. Current lack of efficient extension services in the study areas combined with the extra development activities of extension workers such as input delivery and tax collection, may jeopardize the positive influence of extension on development endeavors.

The effects of the veterinary service on most of the adoption of buffalo dairy production innovations were positive and significant for AI, concentrates, milking place, and vaccination against foot and mouth disease. The results are consistent with other reports on dairy production technologies in Egypt (El-HABAL 1977; SHAHIN, 1995; BALI, 1996; EL-MEKAWY, 1996;HAFZ and ANWAR; 1999; EL-MELEGI, 2000; SALAMA 2001). The consistencies in the

direction of its effect reflect the concentration of veterinarian efforts on to extend beyond disease related technologies and to include dairy production technologies in the region.

The relationship between the adoption of buffalo dairy production innovations and the wealth index was positive for most of the innovations and significant for concentrates, milk replacement, and ecto parasites treatment. The results were in agreement with the findings of several authors (BALI, 1996; EL-HABAL 1995, EL-MAGHAWRY, 1994; EL-TANTAWY, 1998; SOMA and BALI, 1999; SAKR, 2001; MIZHER, 2002; ABD EL-RAZEK, 2002). ABOU EL-SHAHAT (1990) observed a non-significant effect of the wealth index exposure on the adoption of crop production technologies.

Credit did not exert an significant influence on the adoption of most buffalo dairy production innovations studied, probably credit schemes provided to the farmers are targeted for crop production inputs, particularly for the purchase of fertilizer and seeds. The hypothesis was that more such credit would mean more fertilizer input in turn could increase crop production and income thereby promoting investments in dairy production. Credit also played an important role in the uptake of dairy production technologies (FREEMAN et al., 1996). Non-significant effects of credit on the adoption of buffalo dairy production was consistent with the majority of other studies (MUSSEI et al., 2001; BULALE, 2000; GETAHUN et al., 2000; and JABBAR et al., 1998). On the other hand, MUSSEI et al. (2001) and JABBAR et al. (1998) found a relationship between the two variables.

The effect of farm size on the adoption of buffalo dairy production technologies was significant for stable hygiene, AI, milk replacer, and vaccination against Brucellosis. However, the direction of the relationship differed with the technology, positive for stable hygiene and milk replacement and negative for AI and vaccination against Brucellosis. The positive effect of farm size on adoption of stable hygiene and milk replacement might probably be related to the cost involved in cleaning stable and milk replacer. With increased farm size, income of farmers increases too, hence the higher the likelihood affording a higher input level in the dairy production. On the other hand, farm size had a significant and negative influence of the adoption of AI and vaccination against Brucellosis services. Households with smaller farm size adopted artificial insemination and vaccination against brucellosis to a lager degree than farmers with more farm land. The reason could probably be that smaller farmers need to intensify much earlier than

larger farmers to complement the lower income from crop production with increased milk production and thereby increase the return on land.

Differential effects of farm size on technology adoption have been reported by various authors. KEBEDE et al. (1990), in a study on the adoption of single-ox, pesticide, and fertilizer in Ethiopia, reported differential effects of farm size, negative for single-ox technology and positive for pesticide and fertilizer. ZELLER et al. (1998), in Malawi, found that farm size positively and significantly influenced the adoption of tobacco but did not affect the adoption of improved and local maize. BATZ (1999) in Kenya found positive and significant effect of farm size for adoption of cowshed and calf pen, while the effect was negative and significant for fencing technology. However, farm size had no exerted significant influence on the adoption of concentrate feeding and bucket feeding. SHIYANI et al. (2002), MUSSEI et al. (2001), LAPAR and PANDEY (1999), MOHAMED (1996), and ADESINA and BAIDU-FORSON (1995) found no significance influence of farm size on the adoption of crop production in different area. Similarly, studies of dairy production technologies in Kenya were not influenced by farm size (WAITHAKA, 1998). Negative and significant effects of farm size on the adoption of improved dairy production technologies were also reported (BALI, 1996; EL-MELEGI and RAFEE, 1998).

The relationship between the adoption of buffalo dairy production innovations and herd size was positive for most of the innovations and significant for fodder beet, milking place, milk storage in refrigerator, and vaccination against Brucellosis. This was probably because increased herd size of buffaloes would necessitate increased feed availability, insurance that the buffalo remain healthy and improved management, and could be also a mean to save labour devoted for herding activity. The results were in agreement with the findings of Singh et al. (1993), KLOTZ (1995), MADHUKAR and RAM (1996), BALI (1996), JABBAR et al. (1998), HAFZ and ANWAR (1999), EL-MELEGI (2000), SALAMA (2001), MUSSEI et al. (2001), FOLTZ and CHANG (2002), MIZHER (2002), and ABD EL-RAZEK (2002). working on the adoption of improved dairy production technologies in Egypt found positive and significant influence of herd size.

Non-significant effects of herd size on the adoption of improved dairy technologies in Egypt were also reported by YOSSEF (1981), EL-HABAL and OSMAN (1989), and GAD-AL-RAB and SHALABY (1997). Similarly studies on the adoption of improved dairy production technologies in India did not show significant influence of herd size (SINGH et al., 1993).

The relationship between the adoption of buffalo dairy production innovations and milk sales was significant positive for AI, vaccination against foot and mouth disease, and ecto parasite treatment. BATZ (1999) has found positive and significant relationship between adoption of technologies and milk sales. Farmers who market the milk surplus take better care of buffaloes in order to reduce replacement costs, improve feeding and management, thereby increase benefit.

The effect of additional income was positive and significant for AI, mineral salt, and silage from maize. The results were in agreement with the findings of MOHAMED (1996), and ABOUL- EZ (1985). On the other hand, the findings were not consistent with those reported by MUSSEI et al. (2001), GETAHUN et al. (2000), and JABBAR et al. (1998).

The relationship between the adoptions of buffalo dairy production innovations and access to information and external inputs and by the distance to the veterinary unit were negative for most of the innovations and significant for mineral salt, milk storage in refrigerator, vaccination against foot and mouth disease, and vaccination against Brucellosis. Finally, the distance to the next milk collection point negatively and significantly influenced the adoption of maize silage, and vaccination against FMD, which seems to be related to a lower incentive to use inputs for intensifying milk production. The results were in agreement with the findings of BATZ (1999).

Small-scale farms in the area are heavily affected by poor road and transport systems, and market infrastructure, which results in low farm gate prices and high prices for buying food and inputs. High transport costs, the high distribution costs and limited purchasing power of the smallholder agriculture, make marketing costs a principle factor in defining an effective market size. Farmers then find it more profitable to produce their own food than to rely on markets. Milk marketing problem are composed of a low demand in the informal markets and the poor performance of the formal market.

The regression analysis results show that the farmers evaluated innovations against their initial costs, and relative profitability as indicated by significant and negative correlation between relative investment and rate and speed of adoption. The significant correlation between relative complexity and rate and speed of adoption confirm the hypotheses that innovations with a high relative complexity diffused more slowly than the innovations with a low relative complexity.

6 Summary and conclusions

6.1 Summary of research problem and objectives

The Government of Egypt places paramount importance on the agricultural sector, which accounted for about 20% of both the GDP and total exports, and about 34% of the employment in 1998 (NBE, 1998).

Livestock plays an important role in the agricultural sector. Animal production accounted for 30% of the total of agricultural production in Egypt, whereas meat and milk production accounted for 41%, and 26% of the total animal production in 1999, respectively of which 9.9%, and 6.2 of the total meat and milk produced in Menoufia (NAI, 1999).

The last decades of the twentieth century have shown considerable scientific progress, which led to the dissemination or diffusion of many suitable technological innovations and contributed to the development of animal production in Egypt. The government exerted intensive efforts to promote the diffusion and adoption of technological innovations. These efforts include: increasing the number of veterinary units and artificial insemination centers, as well as diffusion of technological packages, such as animal breeding, feeding, housing and management, and health. In addition, introduced efforts for the diffusion and adoption of technological innovations were exerted by the administration of agricultural extension, and of veterinary service, and animal production research institutes.

In spite of these continuous efforts to diffuse technological innovations the adoption results in Egypt are not as desired. Thus, this study aimed to further investigate reasons for successful and unsuccessful technology diffusion and adoption.

Studies in Egypt concentrated in the last years on the adoption of innovations in crop production. Only few dealt with animal production innovations. Thus, the need arose to conduct more studies on adoption of animal production innovations and examine the factors influencing adoption of new dairy technology (BALI, 1996; SHAHIN, 1995; ELHABAL, 1989).

The results of studies in Egypt indicate a shortage of milk and meat production. This shortage is due to the low knowledge and skills of cattle breeders, lack of extension services, lack of resources available to farmers and the use of traditional farming technologies. Several organizations, including international and national agricultural research centers, the World Bank, ministries of agriculture, and nongovernmental organizations, have developed and promoted the use of improved dairy technologies to help increase farm productivity and smallholder income. Yet, the rate of adoption of these technologies among smallholder in Egypt remains low. It appears that many technologies with their specific characteristics seem not to fit into farming circumstances and farmers.

The main aim of this study was to examine the adoption of innovations in smallholder buffalo dairy farms in the Menoufia Province in Egypt. Its specific objectives were to:

- Identify:
  - The communication channels or sources of information of innovations;
  - The level of knowledge of smallholder buffalo dairy farms;
  - The advantages or the reasons for adoption of innovations;
- Study:
  - The relationship between the farmers' characteristics, farm characteristics and adoption of innovations;
  - The influence of innovation characteristics' on the rate and speed of adoption of innovations;
- Determine the reasons for non- adoption or discontinuance of innovations.

6.2 Material and methods

The study was conducted using a random sampling technique involving a total of 180 farmers in six villages in Ashmoun and Shebeen Districts of Menoufia Province. The respondents were stratified according to distance to the district center and to the landholding. Further sampling criteria were the number of buffaloes registered for farmers at the agricultural co-operative of each village. 14 dairy innovations, one for reproduction, five for feeding, four for housing and management, and four for health, were screened for their diffusion and adoption process. Data were collected on the innovation that concerns questions of adopted or not. The current rates and

speeds of adoption were estimated as well as factors determining the adoption using logistic regression models.

6.3 Summary of results

The results of the Logistic regression analysis and Linear regression analysis show the influence of farmer's decisions in adopting dairy innovations, the influence of characteristics of innovations on rate and speed of adoption.

The infrastructure across and within the two Districts various greatly and thus creates considerable differences in farming circumstances. Farmers in the Ashmoun District have generally to cover greater distances to the Ashmoun town, veterinary unit, and next milk collection point. 79% of the farmers are marketing milk. Farmers in the Shebeen District had more access to credit than those in the Ashmoun District. Farmers in the Ashmoun District were wealthier than farmers in the Shebeen El-Kom District. The Ashmoun farmers had a larger average farm size and area under cultivation than Shebeen farmers. Land use pattern showed that in both Districts the largest area of land was allocated to animal feed followed by cash crops and food crops, respectively. The contribution of livestock products to the gross farm output was 68.1%. Ashmoun farmers had more livestock than the Shebeen farmers. Livestock keeping is primarily carried out in the home compounds. The majority of farmers have one or two buffaloes or cows, only some farmers have three, and a small minority has more than three buffaloes. The low number of calves and heifers reflected the low cost-benefit rates for rearing of calves, which are sold after early weaning. This may be related to the serious shortage of feed in the area, which is allocated to those categories providing the highest return. The analysis of performance of the buffaloes (average milk yield, the lactation period) showed a higher yield level in the Ashmoun District than in Shebeen District. The majority of farmers in both districts said that they produced milk as a source of income and for household consumption.

Most farmers were males between 41 and 60 years. Average household size in the Ashmoun District was slightly larger than in the Shebeen District. Farmers in the Ashmoun District, on average, had a lower formal education than farmers in the Shebeen El-Kom District but showed a more active participation in organizations. Farmers in Ashmoun District were more cosmopolitan than those in Shebeen District. More than 80% of farmers are falling in the low and medium

levels of mass media exposure. The highest mean value for farmers' access to extension services and veterinary services was found at Ashmoun district with 65.5% and100%, respectively.

Personal sources of information were more effective than impersonal sources. 89% of farmers were using personal communication as a source of information on all innovations compared with 11% of farmers who were using impersonal communication.

Assessment of technology adoption showed that farmers in the Ashmoun District were more innovative than farmers in Shebeen District. The rate of adoption of all innovations in Ashmoun District was higher than in Shebeen District.

The adoption of reproduction innovations such as AI was low (49%) and had a low speed of adoption because application is related to reliable services.

Animal feed innovations were widely adopted, except for milk replacer and fodder beet. Concentrates had the highest speed of adoption, because concentrate feeding improves milk production. Maize silage was highly adopted and had the highest speed of adoption because maize allows even the farmer with a small piece of land to own a buffalo and to provide feed at low cost.

Housing and management innovations were highly adopted, except milking place. The low adoption and low speed of adoption of milking place supports the hypothesis that small-scale, resource-poor farmers hesitate to adopt innovations that require lumpy capital outlay and are of low utility of farmers.

Animal health innovations were also highly adopted with high speeds because of its cost effectiveness to healthy buffaloes.

Eight out of 14 innovations had over 60% cumulative adoption by 2002. These were: concentrates, mineral salts, maize silage, calf pen, milk storage in refrigerator, vaccination of buffalo against foot and mouth disease, ecto parasites treatment, and endo parasites treatment of calves. Innovations with less than 50% cumulative adoption by 2002 are AI, milk replacement, fodder beet, milking place, and vaccination against Brucellosis.

In 2002, more than 30 years after the first introduction the speed of adoption of some technologies remains low. This implies that the innovations were either not appropriate (a research problem), or they were not diffused well enough in the area (an extension problem) or there were other factors outside research and extension that were impeding adoption such as unfavorable policies. It may also have been caused by combination of the three factors.

Most innovations, however, seem to be appropriate for the region and types of farmers. The characteristics of innovations explained 76% of the rate of adoption and 63% of the speed of adoption by 2002. These characteristics still had the greatest influence on adoption of innovations in the regression model.

The logistic analysis show that the hypotheses developed in chapter 4 could only partly be supported. The result of the logistic regression analysis for factors affecting various buffalo dairy innovations depends on the innovations under consideration.

The age of farmers, labour devoted to crop production and distances to the veterinary unit and to the next milk collection point negatively and significantly influenced the adoption of most buffalo dairy innovations. Level of education of farmers was positively correlated with the adoption of most innovations and significant for AI, ecto parasite treatment, stable hygiene, and milk storage. The relationship between the adoption of buffalo dairy production innovations and social participation was positive for most of the innovations and significant for concentrates, calf pen, and stable hygiene and endo parasite treatment. Cosmopoliteness and contact with veterinarians were positively and significantly affecting the adoption of most buffalo dairy innovations. Mass media exposure and credit were positive and significant for adoption of AI, mineral salt, and ecto parasite treatment. The effects of extension contacts did not influence the adoption of most buffalo dairy production. Wealth index was positive influenced for most of the innovations and significant for concentrates, milk replacement and ecto parasite treatment. The effect of farm size on the adoption of buffalo dairy innovations was significant for stable hygiene, AI, milk replacement, and vaccination against Brucellosis only. Herd size positively influenced on the most of innovations and was significant for green fodder, milking place, milk storage and vaccination against Brucellosis. The effect of milk sales on most of the adoption of buffalo dairy production was positive and significant for AI, vaccination against FMD, and ecto parasite treatment. Additional income positively and significantly influenced the adoption of AI, mineral salt, and maize silage.

Small-scale farm in the area are heavily affected by poor transport, bad road, and market infrastructure, which result in low farm gate prices and high prices for food and inputs. High transport costs, the high distribution costs and limited purchasing power of the smallholder agriculture make marketing costs a principle factor and reduce the degree to which farmers produce for the market and purchase inputs from the market.

The regression analysis results show that the significant and negative correlation between relative investment, relative complexity and rate and speed of adoption. The significant negative correlation between relative complexity and rate and speed of adoption confirm the hypotheses that innovations with a high relative complexity diffused and adopted more slowly than the innovations with a low relative complexity.

The most important reason for rejection of AI was the unreliability of AI service. The most important reasons for rejection of feeding innovations were: preference to feed the animals with the locally available dry straw due to low purchasing power, lack of extension service on dairy production, suckling is better than milk replacement, and lack of knowledge in preparing silage.

The probable reasons for non-adopting feeding innovations could be it high cost of concentrate feeding for poor farmers, exploitation by private vendors due to marketing problems in flush seasons, and lack of sufficient resources and low social economic status for getting loans.

The most important reasons for non-adoption of housing and management innovations were: The current building legislation does restrict farmers to make farm constructions, calves were sold after early weaning, and lack of knowledge. The most important reasons for non- adoption and discontinuation of health innovations were: absence of diseases, far distance of veterinary unit, and absence of external and internal parasite.

6.4 Conclusions and recommendations

6.4.1 Appropriateness of technologies

In the study areas, family members are the most important sources of labour. In addition, responsibilities of dairy buffalo management lay in members of the family with a high status,

husband and wife. A dairy buffalo is also an important source of income to the household in both districts. Dairy buffalo is the most important component of farming activities in the study areas.

The characteristics of innovations as expressed by farmers explain a large proportion of the adoption and speed of adoption technologies in buffalo dairy production. By focusing on these characteristics, other than farmer conditions and circumstances, research can improve the chances of adoption of future technologies.

The study indicates that some of the characteristics of farmers and farms, namely, knowledge of dairy farming, educational level, social participation, cosmopoliteness, mass media exposure, herd size, credit, milk sales, etc., help in determining adopters of dairy farming practices. This information should be used to positively change farmers' characteristics in order to improve technologies. Animal feed innovations were highly adopted except milk replacer and fodder beet. Maize silage production had the highest speed of adoption (4.8%) due to its economic profitability (reducing demand on land, increasing milk yield). The relative advantage of feeding innovations due to the higher milk yield production, the higher value of silage for milk production and lower cost of silage maize.

The farmers in the study area adopt calf pens in order to increase the economic return and decrease the cost for veterinary services. The relative advantage of improved milk storage is related to improved milk quality.

The main advantages of adoption of health technologies were to ensure that the buffalo remains healthy, increase milk production, decrease the expenditure of veterinary services and finally increase the economic revenue.

Speed of adoption of milk replacer, fodder beet and vaccination against Brucellosis has been low due to inadequate extension and veterinary services, low incentives due to ineffective marketing infrastructure, markets, and inappropriate technologies where support services delivery and infrastructure such as access roads have been weak.

With increasing pressure on irrigated land in the Delta (Nile Valley), there is a need to increase land and labour productivity, such as shifting from low return subsistence food crops towards high value added enterprises, e.g. dairy production. This transformation to commercialization can

only be achieved through well-developed road and transport infrastructure and well organised input and output markets. The other requirements are enhancing extension services and service delivery systems that respond effectively to farmers' demands.

6.4.2 Credit and extension

Extension is an on-going process of getting useful information to farmers (communication dimension) of assisting those farmers to acquire the necessary knowledge, skills, and attitudes to utilize effectively this information or technology (the educational dimension) and to analyse farm technology options for future use.

Credit and extension services are important institutions to support farmers' own efforts. The inability of farmers to adopt innovations has many causes but lack of resources, inability to access credit and general lack of capital could be cited as the major causes of the lower adoption rates. In the study areas, credit was only provided to crop production inputs and no credit scheme was available for the development of smallholder dairy farmers. Facilities of the loan by rural agricultural banks for the purchase of appropriate number of dairy buffalo, construction of milking place, calf pen, medicaments and purchase of inputs should be made available on easy terms. Policy-makers and financial institutions should carefully target those farmers that need additional capital in order to obtain greatest impact from credit.

One of the major constraints of the extension agency in Egypt is the very small amount of feedback on agricultural practices and improved inputs coming from the farm into the extension and the research system. In this study, the effects of extension were negative but not significant on most of buffalo dairy innovations because extension activities regarding dairy production technologies were generally very weak. Whatever extension efforts being undertaken were directed to improve crop production levels.

There is a need to enhance dairy extension services through carefully examine the current extension system in the high potential dairy region, i.e., Ashmoun and Shebeen Districts. Either, they should also be provided with adequate and reliable transportation facilities to enable them to meet with farmers, or the delivery of extension messages require a different approach, such as village meeting with clientele, training and visit system, the field trip, field day, and modified conference methods with extension officers.

6.4.3 Marketing

Livestock enterprises are constrained by marketing problems for milk and live animals, poor veterinary services, and lack of artificial insemination facilities. The major constraint -milk marketing – is due to a lack of collection centers, long distances to markets, low price of milk, and unfair transactions with traders. The producers themselves consume much of the milk, but a marketable surplus does exit. Collecting this scattered surplus for transport and wholesale trading, however, presents a problem. For small land holdings, research aimed at improving the economic environment of agriculture in the rural areas is particularly require and should include: prices and profitability, factor cost and availability, rural infrastructure development, access to and effectiveness of support services and rural market environment.

6.4.4 Breeding program

The results of this study show that more than 50% of the farmers in the study area were using natural mating with buffalo bulls kept by individual farmers while the farmers in and around cities were using AI. The farmers at Ashmoun and Shebeen Districts were getting the bull service without any major problem and had no difficulty in bringing a buffalo in heat to a bull service farm. The results also indicate that a significant proportion of farmers were not familiar with AI service. A number of reasons like organizational problems associated with the administration of the AI service, unreliability of AI, lack of well trained and experienced AI technicians contribute to the poor effectiveness of the AI service in the study areas.

Therefore, the extension agencies and veterinarians can organise educational activities to enrich the knowledge of reproduction by improving the overall efficiency of AI technicians by imparting proper training and by providing incentives to the dairy farmers to use AI.

6.4.5 Feeding

Feed supply is the main limiting factor for cattle and buffalo production in the study area; the feed available is mainly used to satisfy animals' maintenance requirements and consequently production levels are low.

The constraints of feeding innovations can be eliminated by enriching the knowledge of dairy farmers through intensive extension educational activities on the importance of balanced feeding, by organizing more skill oriented training programms on feeding by organizing more method demonstrations on preparation of concentrate feed mixture with local available ingredients and preparation of maize silage.

Therefore, the various organizations connected with dairy development may formulate suitable training programms on various aspects of management and also strengthen the educational activities to meet the requirements of the dairy farmers.

6.4.6 Veterinary

The various organisations aimed at dairy development like veterinary units and animal husbandry departments can eliminate the constraints of health by making plans to organise more training programs and also adopt various educational activities as well as supplying adequate quantities of veterinary drugs. Research on disease prevention and delivery of animal health technologies should be maintained.

6.4.7 Linkage between research, extension, veterinarians and farmers

The Assistant Director (AD) in charge of the animal production department in Menoufia Governorate should provide the overall leadership, being the person who is directly responsible for implementation of the results. The AD will also have to present the outcomes to Agricultural Research Center ARC management for funding support and it must be in agreement with the process and methodologies. The AD must identify the objectives of target areas, and select new research activities or eliminate certain activities in order to make room for new issues. These goals should reflect the aspiration of the division as well as the ARC in general. Guidance must also be provided by the AD on how and where the interests of donors should fit in the programme.

Both, farmers and other stakeholders should be represented in national and regional research centers. These teams should utilise the existing clusters, which include local extension agent at the regional level. In all cases, multidisciplinary teams should be used to represent all thrusts.

There should be representatives for feed resources and utilisation, animal health, animal breeding, and genetic improvement and socio-economics. This is to expose many researchers to farmers' conditions and circumstances and informal methodologies.

Provision for marketing facilities, compounded feed and pellets, mineral mixture, veterinary aid, preventive vaccination and other important facilities should be made available to help in promoting scientific dairy farming.

6.5 Summaries of the study

6.5.1 English short summary

The objectives of this study were to: 1. Identify the information of sources of innovations, 2. Identify the level of knowledge of innovations, 3. Study the relationship between the farm circumstances, farmers' characteristics, farm characteristics and adoption of innovations, 4. Study the influence of innovation characteristics' on the rate and speed of adoption of innovations, 5. Determine the reasons for non- adoption of innovations, 6. Identify the advantages or the reasons for adoption of innovations.

Field surveys were conducted in Ashmoun and Shebeen El-Kom Districts in Menoufia province in Egypt. The present study used a random sampling technique to involve a total of 180 farmers covering six villages (thirty farmers from each village) in Ashmoun and Shebeen Districts of Menoufia province. 14 dairy innovations, 1 for reproduction, 5 for feeding, 4 for housing and management, and 4 for health were screened for their diffusion and adoption process. Data collected concerns questions of adopted or not. The current rates and speeds of adoption were estimated as well as factors determining the adoption using logistic regression models.

The age of farmers, labour devoted to crop production and distances to the veterinary unit and the next milk collection point negatively and significantly influenced the adoption of most buffalo dairy innovations. Level of education of farmers was positively correlated with the adoption of most innovations and significant for AI, ecto parasite treatment, stable hygiene, and milk storage. Cosmopoliteness and veterinarian were positively and significantly affecting the adoption of most buffalo dairy innovations. Mass media exposure, credit and contact with veterinarians were positive and significant for adoption of AI, mineral salts, and ecto parasites treatment. The effects

of extension did not influence the adoption of most buffalo dairy production. The relationship between the adoption of buffalo dairy production innovations and wealth index was positive for most of the innovations and significant for concentrates, milk replacement, and ecto parasites treatment. The effect of farm size on the adoption of buffalo dairy production technologies was significant for cleaning stable, AI, milk replacement, and vaccination against Brucellosis. The relationship between the adoption of buffalo dairy production innovations and herd size was positive for most of the innovations and significant for fodder beet, milking place, milk storage in refrigerator, and vaccination against Brucellosis. The effect of milk sales on most of the adoption of buffalo dairy production technologies was positive and significant for AI, vaccination against foot and mouth disease, and ecto parasites treatment. Additional income positively and significantly influenced the adoption of AI, mineral salts, and silage from maize.

The regression analysis results show that the significant and negative correlation between relative investment, and complexity and rate with speed of adoption.

6.5.2 Deutsche Kurzzusammenfassung

Die Ziele dieser Studie waren: 1. Identifizierung der Informationsquellen über Innovationen von kleinbäuerlichen Milchbüffelhaltern in der Provinz Menoufia in Ägypten, 2. Identifizierung des Wissensstandes über Innovationen dieser Kleinbauern 3. Untersuchung der Beziehungen zwischen den landwirtschaftlichen Produktionsbedingungen, Eigenschaften der Betriebssysteme sowie der Bauern, und die Annahme von Innovationen, 4. Untersuchung des Einflusses von Innovationseigenschaften auf die Rate und Geschwindigkeit der Adoption von Innovationen durch die Kleinbauern 5. Bestimmung der Gründe für die Nicht-Adoption oder Unterbrechung der Innovationen 6. Identifizierung von Vorteilen bzw. Gründen für die Adoption von Innovationen.

Die empirischen Untersuchungen wurden im Gebiet Ashmoun and Shebeen El- Kom in der Provinz Menoufia, Ägypten, durchgeführt. Für die vorliegende Untersuchung wurden zufällig 180 Kleinbauern ausgewählt, und zwar jeweils dreißig Landwirte aus insgesamt sechs Dörfern. Es wurden insgesamt 14 Innovationen der Milcherzeugung ausgewählt, und zwar eine im Bereich Reproduktion, 5 im Bereich Fütterung, 4 im Bereich Stallbau - Management und 4 im Bereich Tiergesundheit. Hierbei wurde die Zeit der ersten Nutzung der Innovation sowie die Adoptionsraten während der Untersuchung festgehalten. Die jetzigen Adoptionsraten und -

geschwindigkeiten sowie Einflussfaktoren auf die Adoption wurden an Hand logistischer Regressionsmodelle geschätzt.

Das Alter der Bauern, Arbeitsanspruch für die Getreideproduktion und die Entfernung von tierärztlichen Stationen und zur nächsten Milchsammelstelle hatten auf die meisten Technologien einen signifikant negativen Einfluss. Das Ausbildungsniveau hatte einen positiven Effekt auf die meisten Technologien und signifikant beeinflusste die Adoption der Künstlichen Besamung und Ektoparasitenbehandlung, die Stallreinigung und die Milchkühlung. Kosmopolitismus hatte einen positiven und signifikanten Effekt auf die Annahme von Konzentraten, Milchkühlung, Endo- und Ektoparasitenbehandlung. Die Auseinandersetzung mit Massenmedien, die Kreditaufnahme und der Kontakt zu einem Tierarzt hatten einen signifikant positiven Effekt auf die Annahme der Künstlichen Besamung, Bereitstellung von Mineralsalzen und Ektoparasitenbehandlung. Die landwirtschaftliche Beratung hatte auf die meisten Technologien keinen Einfluss. Der Wohlstandsindex hatte auf die meisten Technologien einen positiven Einfluss, der die Signifikanzgrenze von $p < 0.05$ für die Annahme von Konzentraten, Milchaustauschern und Ektoparasitenbehandlung erreichte. Die Betriebsgröße hatte einen signifikanten Effekt auf die Annahme der Stallreinigung, der Künstlichen Besamung, Milchaustauscher und Impfung gegen Brucellose. Die Herdengröße war positiv korreliert mit der Adoption von Futterrüben, Melkstand, Milchkühlung und Impfung gegen Brucellosis. Der Verkauf von Milch hatte einen positiven auf die meisten Technologien und einen signifikanten Effekt auf die Annahme der Künstlichen Besamung, Impfung gegen Maul- und Klauenseuche und Ektoparasitenbehandlung. Ein zusätzliches Einkommen beeinflusste die Annahme von Künstlicher Besamung, Mineralsalzen, und Maissilage signifikant positiv.

Die Ergebnisse der Regressionsanalyse zeigen eine signifikant negative Korrelation zwischen der für die Innovation erforderlichen relativen Investition, relativen komplextät und der Adoptionsrate und -geschwindigkeit.

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8. Appendices

A. Questionnaire used in survey

Farmer survey number:.....……

Date:.....…….

District:.....…….

Village:.....…….

Distance to the veterinary unit .....……

Distance to the town .....……

Distance to the next paved or tarmac .....

Technology information

Artificial insemination

1. Have you ever heard of AI? Yes ( ) no ( )
2. If the answer is yes, when did you first heard of AI? Year .....
3. How or from whom did you first learned or heard about AI?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

4. Have you tried AI? Yes ( ) no ( )
5. If the answer is no, what are the reasons that you do not use AI ?

a..... c.....
b..... d.....

6. If yes, when you first tried AI? Year .....
7. Who did AI for your animals? .....
8. How much was paid for AI? Pound.....
9. Are you still using AI? Yes ( ) no ( )
10. If the answer is no, when did you interrupted or stopped ? Year.....

and why did you interrupted (stopped)? .

a..... c.....
b..... d.....

11. What is the number of year which you are used AI? Year .....
12. What are the advantages or why you use AI ?

a..... c.....
b..... d.....

13. How many inseminations per conception for buffaloes?
14. Where is the artificial insemination center?

In your village ( )in the adjacent village ( )In district ( )

15. Do you practice nature mating in your farm? Yes ( ) no ( )
16. If yes how much paid for the natural mating?
17. How many mating per conception for buffaloes?

Concentrate feeds for buffaloes

18. How are feed of buffaloes?

1. 2. 3. 4.

19. Have you ever heard of concentrates feeds for buffaloes ? Yes ( ) no ( )

20. If the answer is yes, when did you first heard of concentrates feeds for buffaloes? Year…

21. If yes, what types of concentrate are used?.....

22. How or from whom did you first learned or heard about Concentrate feeds for buffaloes?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

23. Have you tried Concentrate feeds for buffaloes ? yes ( ) no( )

24. If the answer is no, what are the reasons that you do not use concentrates feeds for buffaloes?

a..... c.....
b..... d.....

25. If the answer yes, when you first tried ? year .....

26. Are you still using concentrates feeds for buffaloes? Yes ( ) no ( )

27. If the answer is no ,when did you interrupted or stopped? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....

28. What the number of year which you are used concentrates feeds for buffaloes? Year.....

29. What are the advantages when you use concentrate feeds for buffaloes?

a..... c.....
b..... d.....

Use mineral salts

30. Have you ever heard of use mineral salts for buffaloes? Yes ( ) no ( )

31. If the answer is yes, when did you first heard of use mineral salts? year .....

32. How or from whom did you first learned or heard about use mineral salts?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

33. Have you tried minerals feeds for buffaloes ? yes ( ) no ( )

34. If the answer is no, what are the reasons that you do not use mineral salts ?

a..... c.....
b..... d.....

35. If the answer yes, when you first use mineral salts? year .....

36. How much paid for mineral salts last time? Pound .....

37. Are you still using mineral salts for buffaloes? Yes ( ) no ( )

38. If the answer is no, when did you interrupted or stopped? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....

39. What the number of year, which you are used minerals? Year.....

40. What are the advantages when you use concentrate feeds for buffaloes?

a..... c.....
b..... d.....…

Use the milk replacement for the calves feeding.

41. Have you ever heard of use the milk replacement? Yes ( ) no ( )

42. If the answer is yes, when did you first heard of use the milk replacement? Year .....

43. How or from whom did you first learned or heard about use the milk replacement?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

44. If the answer is no, what are the reasons that you do not use the milk replacement?

a..... c.....
b..... d.....…

45. If the answer yes, when you first tried use the milk replacement? Year .....

46. Are you still using milk replacement? Yes ( ) no ( )

47. If the answer is no, when did you interrupted or stopped? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

48. What the number of year, which you are, used the milk replacement? Year……..

49. What are the advantages when you use the milk replacement?

a..... c.....
b..... d.....…

Maize silage.

50. Have you ever heard of making maize silage? Yes ( ) no ( )

51. If the answer is yes, when did you first heard of making maize silage? year .....

52. How or from whom did you first learned or heard about making silage from maize?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

53. Have you tried making silage from maize? Yes ( ) no ( )

54. If the answer is no, what are the reasons that you do not make maize silage?

a..... c.....
b..... d.....…

55. If the answer yes, when you first making maize silage? year .....

56. The amount making last year Ton …….

57. How much paid for making maize silage? Pound .....

58. Are you still using or making maize silage? Yes ( ) no ( )

59. If the answer is no, when did you interrupted or stopped? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

60. What the number of year, which you are making maize silage? Year.....

61. What are the advantages when you use maize silage for feeding buffaloes?

a..... c.....
b..... d.....…

Use the fodder beet feeds for buffaloes.

62. Have you ever heard of use the fodder beet? Yes ( ) no ( )

63. If the answer is yes, when did you first heard of use the fodder beet? Year .....

64. How or from whom did you first learned or heard about use the fodder beet?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

65. If the answer is no, what are the reasons that you do not use the fodder beet?

a..... c.....
b..... d.....…

66. If the answer yes, when you first tried use the fodder beet? Year .....

67. Are you still using use the fodder beet? Yes ( ) no ( )

68. If the answer is no ,when did you interrupted or stopped ? Year .....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

69. What the number of year, which you are used use the fodder beet? Year.....

70. What are the advantages when you use the fodder beet feeds for buffaloes?

a..... c.....
b..... d.....…

Milking place

71. Have you ever heard of milking place? Yes ( ) no ( )

72. If the answer is yes, when did you first heard of milking place? year .....

73. How or from whom did you first learned or heard about milking place?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

74. Have you tried milking place? Yes ( ) no ( )

75. If the answer is no, what are the reasons that you do not use milking place?

a..... c.....
b..... d.....…

76. If the answer yes, when you first tried milking place? Year .....

77. Are you still using milking place? Yes ( ) no ( )

78. If the answer is no ,when did you interrupted (stopped ? Year .....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

79. What the number of year which you are used milking place? Year.....

80. What are the advantages when you use milking place?

a..... c.....
b..... d.....…

Milk storage in refrigerator.

81. Have you ever heard of milk storage in refrigerator? Yes ( ) no ( )

82. If the answer is yes, when did you first heard of milk storage in refrigerator? Year .....

83. How or from whom did you first learned or heard about milk storage in refrigerator?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

84. Have you tried Storage milk in refrigerator? Yes ( ) no ( )

85. If the answer is no, what are the reasons that you do not use milk storage in refrigerator?

a..... c.....
b..... d.....…

86. If the answer yes, when you first tried milk storage in refrigerator? year .....

87. Are you still using milk storage in refrigerator? Yes ( ) no ( )

88. If the answer is no, when did you interrupted (stopped? year .....

89. and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

90. What the number of year, which you are used milk storage in refrigerator? Year.....

91. What are the advantages when you use milk storage in refrigerator?

a..... c.....
b..... d.....…

Calf pen

92. Have you ever heard of calf pen? Yes ( ) no ( )

93. If the answer is yes, when did you first heard of calf pen? year .....

94. How or from whom did you first learned or heard about calf pen ?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

95. Have you tried calf pen? Yes ( ) no ( )

96. If the answer is no, what are the reasons that you do not use calf pen ?

a..... c.....
b..... d.....…

97. If the answer yes, when you first installed calf pen? Year .....

98. Are you still using calf pen? Yes ( ) no ( )

99. If the answer is no, when did you interrupted? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

100. What are the advantages when you use calf pen?

a..... c.....
b..... d.....…

Stable hygiene

101. Have you ever heard of stable hygiene? Yes ( ) no ( )

102. If the answer is yes, when did you first heard of stable hygiene? year .....

103. How or from whom did you first learned or heard of Stable hygiene?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )

Extension leaflets ( ) Radio ( ) T.V ( )

104. Have you tried currently cleaning stable? Yes ( ) no ( )

105. If the answer is no, what are the reasons that you do not use stable hygiene?

a..... c.....
b..... d.....…

106. If the answer yes, when you first tried stable hygiene? year .....

107. How much paid for cleaning stable? Pound.....

108. How often do you stable hygiene? Frequency per year ( )

109. Are you still using stable hygiene? Yes ( ) no ( )

110. If the answer is no, when did you interrupted (stopped)? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

111. What the number of year, which you are used stable hygiene? Year.....

112. What are the advantages when you cleaning /disinfections stable?

a..... c.....
b..... d.....…

Vaccination against foot and mouth disease (FMD)

113. Have you ever heard of vaccination against FMD? Yes ( ) no ( )

114. If the answer is yes, when did you first heard of vaccination against FMD? year .....

115. How or from whom did you first learned or heard vaccination against FMD?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

116. Have you tried (VBACAFAMD? Yes ( ) no ( )

117. If the answer is no, what are the reasons that you do not vaccinate against FMD?

a..... c.....
b..... d.....…

118. If the answer yes, when you first tried vaccination against FMD? year .....

119. Are you still using vaccination against FMD? Yes ( ) no ( )

120. If the answer is no, when did you interrupted or stopped? year .....

and why you interrupted (stopped)?

a..... c.....
b..... d.....…

121. What the number of year which you are used vaccination against FMD? Year.....

122. What are the advantages when you use vaccination against FMD?

a..... c.....
b..... d.....…

Vaccination buffaloes against Brucellosis.

123. Have you ever heard of vaccination against brucellosis? Yes ( ) no ( )

124. If the answer is yes, when did you first heard of vaccination against Brucellosis?

Year…….

125. How or from whom did you first learned or heard vaccination against Brucellosis?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

126. Have you tried vaccination buffaloes against brucellosis? Yes ( ) no ( )

127. If the answer is no, what are the reasons do not use vaccination against Brucellosis?

a..... c.....
b..... d.....…

128. If the answer yes, when you first tried vaccination against Brucellosis? Year……

129. Are you still using vaccination against Brucellosis? Yes ( ) no ( )

130. If the answer is no, when did you interrupted (stopped)? Year.....

and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

131. What the number of year that you are used vaccination against Brucellosis? Year…..

132. What are the advantages when you use vaccination buffaloes against brucellosis?

a..... c.....
b..... d.....…

Ecto parasites treatment to buffaloes

133. Have you ever heard of Ecto parasites treatment to buffalo? Yes ( ) no ( )

134. If the answer is yes, when did you first heard of Ecto parasites treatment? Year ….

135. How or from whom did you first learned or heard Ecto parasites treatment ?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

136. Have you tried Ecto parasites treatment to buffalo? Yes ( ) no ( )

137. If the answer is no, what are the reasons that you do not use Ecto parasites treatment ?

a..... c.....
b..... d.....…

138. If the answer yes, when you first tried Ecto parasites treatment? Year …...

139. How much paid for Ecto parasites treatment to buffalo? Pound .....

140. Are you still using Ecto parasites treatment to buffalo? yes ( ) no ( )

141. If the answer is no, when did you interrupted (stopped? Year.....
and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

142. What the number of year, which you are, used Ecto parasites treatment? Year.....

143. What are the advantages when you use Ecto parasites treatment?

a..... c.....
b..... d.....…

Endo parasites treatment to calves

144. Have you ever heard of endo parasites treatment? yes ( ) no ( )

145. If the answer is yes, when did you first heard of endo parasites treatment? year .....

146. How or from whom did you first learned or heard endo parasites treatment?

Extension workers ( ) Veterinarian ( ) Traders ( )
The private sector companies ( ) Family members ( ) Neighbors ( )
Extension leaflets ( ) Radio ( ) T.V ( )

147. Have you tried currently endo parasites treatment to calves? Yes ( ) no ( )

148. If the answer is no, what are the reasons that you do not use endo parasites treatment?

a..... c.....
b..... d.....…

149. If the answer yes, when you first tried endo parasites treatment? year .....

150. How much paid for endo parasites to calves? Pound.....

151. How often does you use endo parasites treatment? Frequency per year ( )

152. Are you still using endo parasites to calves? Yes ( ) no ( )

153. If the answer is no, when did you interrupted (stopped)? Year.....
and why did you interrupted (stopped)?

a..... c.....
b..... d.....…

154. What the number of year, which you are, used endo parasites treatment? Year.....

155. What are the advantages when you using endo parasites treatment?

a..... c.....
b..... d.....…

Farmer's Characteristics

156. Who manage the farm? Male = M ( ) Female =F ( )

157. Age of farmer ..... Year

158. Family status: Married ( ) Unmarried ( ) Divorced ( ) Widowed ( )

159. Family size .....

160. How many member of the family work on the farm?.....

161. How many workers not from the family work in the farm?

Type of worker	Number of workers	Cost
Permanently		
Seasonally		

162. Level of formal education of farmer ……

Social participation

163. What is the organization you are participated?

Item	Type of organization	Membership		
		No member	Ordinary member	Committee Administration member
1	Agricultural association cooperative			
2	Village local council			
3	Association vegetable			
4	Association consumption			
5	Association society development			

164. Do you have additional occupation besides working in the farm? yes ( ) no ( )

165. If yes, what is this occupation ?

166. Income from this occupation? Pound…….

Cosmopoliteness

167. Do you visit other surrounding villages or cites in the last Year?

Item	No visited	Weekly	Monthly	6 month	Yearly
Visit to surrounding villages					
Visit to Shebeen el-kom town					
Visit to Ashmoun town					
Visit to other governorates					

168. Mass media Exposure

Do you…….	Always	Sometimes	Rarely	No
See T.V				
See Agricultural program in T.V				
Listen Radio				
Listen Agricultural program in Radio				
Read the Newspaper				
Read Agricultural Magazine				

Contact with extension workers

169. Do you know the village extension workers for animals? Yes ( ) no ( )

170. If yes, do you visit them?

Once every week ( ) once every month ( ) once every three month ( )

171. Did you talk with them about?

Feeding animal ( ) Health animal( ) Husbandry animal ( ) breeding ( )

172. What are the new ideas that the extension told you to do?.....

173. Did you carry out any of these ideas in your farm ?……..

Contact with veterinarian

174. Do you know the veterinary service? Yes ( ) no ( )

175. If yes, do you visit veterinarian?

Once every week ( ) once every month ( ) once every three month ( )

176. Did you talk with them about ?

Feeding animal ( ) Health animal( ) Husbandry animal ( ) breeding ( )

177. What are the new ideas that the veterinary service told you to do? ….....

178. Did you carry out any of these ideas in your farm?…….....

179. Is possible for you to get credit for the farm? Yes ( ) no ( )

180. If yes fill the table, record all credit obtained during last year.

Source of credit	Purpose of credit	Total amount

Level of living (wealth index)

181. What is the number of the room in your house? Room .....

182. Have you electricity on your home? Yes ( ) no ( )

183. If yes , what is the electric sets which you have owned?

1. 2. 3. 4.

184. Have you source of pure water at the home? Yes ( ) no ( )

185. Have you agricultural machine on your farm? Yes ( ) no ( )

186. If yes What is the agricultural machine you have in your farm?

1. 2. 3. 4.

Farm Characteristics

187. How many Fadden you have on your the farm?

Owned ..... Fadden Rented.....Feddan Total.....

188. Type of crops which the farmer cultivated:

Crops	Area cultivated (feddan)	Production
Maize		
Egyptian clover (or Berseem)		
Wheat		
Potatoes		
Cotton		
Fruits		
Vegetables		

189. Crop Input and output used in the last production year

Crop	Area	Average production	Cost	Income	Consumption
Maize					
Berseem					
Wheat					
Potatoes					
Cotton					
Fruits					
Vegetables					

Livestock information

190. What is the number of buffalo which the farmer owned

Type of animal	Menoufi	Saidi
Buffaloes adult		
Heifers		
Bull		
Calves		

191. Livestock herd size and composition

Type of cattle	Breed	Number of animal
Cattle	Local/Baladi	
	Crossbreed	
	Exotic	
Sheep	Osimi	
	Rahmani	
Goat		
Donkeys		

192. What is the purpose of breeding buffaloes?

Milk production ( ) Meat production ( ) Milk and meat production ( )

193. What kind of milking operation managed to the animal ? Manual ( ) Automatic ( )

194. Who operates the milking operation? Male = M ( ) Female =F ( )

195. What is the method which you are using of milking buffaloes?

a. Milking without calf present ( )
b. Milking with calf present ( )
   1. Stimulation before milking without suckling ( )
   2. Suckling followed by milking ( )
   3. Milking followed by suckling ( )
   4. Suckling before and after milking. ( )

196. How long can the calves suckle the buffalo? Week

197. What is the average quantity of milk you got from your buffalos last time and how long did you milk your buffaloes?

Buffalo number	Daily milk yield			Lactation length (day)
	Beginning of Lactation	Middle of Lactation	End of Lactation	

198. Animal production input s used in the last year

Type of cost	Cost Pound
Feeding	
Treatment of the disease	
Service	

Marketing information

199. How do you market the milk currently and what is the price per kg?

Dairy society ( ) price pound
Local sales in village ( ) price pound
In the town ( ) price pound
Someone collect from my farm ( ) price pound

200. How far away from the farm to the milk collection point and how does the farmer transport the milk to the collection point?

Distance to the collection point in km	
Distance in hours	
Type of transport	

201. Who decides about the money obtained from milk marketing?

Wife ( ) Husband ( ) Both ( )

202. Buffaloes production (output of the farm)

Item	Consumption	Sales	Price
Liquid milk			
Samna			
Cheese			
A cream			

203. Number of calves sales in the last year.

Number of calves	Price
1.	
2.	
Total	

Appendix B. Questionnaire for Extension workers

1. Name of extension worker…….
2. Age of extension worker. Year……
3. Number of year of formal education……..
5. Please let the extension workers give a score (1 to9) to the cost and profitability assessment and a score from (1 to 3) to the complexity for each innovation.

Innovations	Cost	Benefit	Complexity
Artificial insemination			
Natural mating			
Concentrate feeds for buffaloes			
Mineral salts			
Maize silage			
Use the fodder beet for feed buffaloes			
Using of straw and hay for feeding buffaloes			
Use milk replacements for the calves			
Suckling			
Milking place			
Conventional milking			
Milk storage in refrigerator			
Tradational storage of milk			
Calf pen			
Tethering			
Vaccination buffaloes against foot and mouth disease			
Vaccination buffaloes against brucellosis			
Ecto parasites treatment to buffalo			
Traditional ticks			
Endo parasites treatment to calves			
Traditional Endo parasites treatment			
Cleaning/ disinfections stable			
Hand removal of ticks on housing			

1.very low, 9.very high.
1 simple, 3 complex.

Appendix C. Operational Definitions

Farmer's characteristics

Gender of manger

Gender of manger was measured by the question*what is gender of manager*.

Age of farmer

Chronological age of farmer was measured by the question * How old are you*.

Family status

Family status was measured by the question * what is your family status*. Each respondents was asked to choose one of the four responses: Married=4,unmarrid=3, discovered=2,widowed =1.

Family size

Family size was measured by the question *How many persons are in your family *.

Number of the family member work on your farm

This variable was measured by the question *how many members of the family work on farm.

Hired labour

Labour was measured by the question how* many workers work on your farm*. For each respondent was asked to write number of permanently and seasonally Workers and cost.

Level of education

Level of education was measured by*how many years of formal education does the farm manger have?

Social participation

This variable was measured by the surrogate sum organizational membership for the following organization categories: agricultural cooperative and so……. .For each membership farmers answering* committee member*to this question were given a score 3 and those answering *ordinary member and no member * were given a score 2and 1 respectively.

Additional occupation

This variable was measured by the question *do you have another occupation *. Farmers answering (No) were given a score 1 and those answering (yes) were given a score 2.

Cosmopoliteness

Cosmopolitans were measured by the sum of the four questions (during the last year, do you visit other surrounding villages or cities or other governorates). Farmers answering (No visit) to this question were given a score zero and those answering (weekly, monthly, 6 month, yearly) were given a score (4,3,2,1,) respectively.

Mass media Exposure

Mass media exposure was measured by the question *do you watch agricultural program in television and/or to them in radio, and do you read newspaper and agricultural magazines. The respondents were asked to choose one of the responses: Always=4,somtimies=3,rarely=2,no=1*.

Contact with extension workers

These were measured by the questions (do you know and vist the extension worker). Farmers answering *No* were given a score 1 and those answering *yes* were given a score 2.

Contact with veterinarians

This variable was measured by the questions (do you know and visit the veterinarian). Farmers answering *No* were given a score 1 and those answering *yes* were given a score 2.

Farm characteristics

Farm size

Farm size was measured by the question* how many feddan you have on your farm*.

Credit

Credit was measured by the question* do you obtain credit during last year and the amount of this credit. Farmers answering (No) to this question were given a score 1 and those answering (yes) were given a score 2.

Gross farm output

Farm income was measured by the gross farm output from cropping and livestock activities using the information, which collected from the sampled farmers. It was calculated from the valued production of crops and livestock for subsistence and for sale, excluding changes of animal herd and animal transactions (sales and purchases). When direct expenses, i.e. for seed, fertilizer, chemical, labor, expenses for animal feed, veterinary services and other variable inputs were deduced, the gross margin was obtained.

Herd size

Each kind of animal was given agreed upon factor named tropical livestock units (TLU), commonly taken to be an animal of 250 kg in liveweight (EL-Habal, 1977; Eltobgy, 1983; Gryseels, 1988; Bally, 1996; Bulale, 2000). This animal unit was as follows:

Livestock type	TLU	Livestock type	TLU
Buffalo	1.25	Heifer	0.5
Buffalo bull	1.25	Calve	0.2
Buffalo heifers	0.6	Sheep	0.09
Buffalo calves	0.3	Goat	0.09
Ox-bull	1.10	Camel	0.75
Cow local	0.8	Donkey	0.36
Cow cross	1.2	Horse	0.8

The total number of livestock by the farmer was, therefore, the sum of the convert values in* TLU* of the number of all species of livestock owned by the farmer excluding chicken.

Purpose of breeding buffaloes

The purpose of breeding buffaloes was measured by the question (What the purpose of breeding buffaloes. Farmers answering (milk production, milk and meat production, meat production) were given a score 3,2,1 respectively.

Local infrastructure

Local infrastructure was measured by the information about Kilometers that farmers have to travel in order to reach place input supply services and marketing Shebeen El- Kom or Ashmoun town*, next veterinary unit and to the next milk collection point, and to the next paved road (km).

Information of innovations

Availability source of information

Source of information used at the awareness stage was measured by the question *how did you first learn about the buffalo dairy innovations). Each respondent was asked to determine the relative importance source of information about innovations. Sources of information include family members and neighbors, extension workers, veterinarian, traders, the private sector companies, Extension leaflets, Radio and T.V.

Level of awareness of buffalo dairy innovations

The respondent's general awareness of buffalo dairy innovation in Menoufia Governorate in Egypt was measured by the question *have you heard of the following dairy innovations*: Artificial insemination, concentrate feeds for buffaloes, mineral salts for buffaloes, use milk replacements for feed the calves, making silage from maize, use fodder beet for feed the buffaloes, milking place, calf pen, milk storage in refrigerator, vaccination buffaloes and calves against foot and mouth disease, vaccination buffaloes against Brucellosis, ecto parasites

treatment, endo parasites treatment, and cleaning /disinfections stable. Farmers answering (No) to this question were given a score 1 and those answering (yes) given a score 2.

Year of Awareness

In order to measure awareness, each respondent was asked to indicate when he/she first heard about dairy innovations.

Adoption of buffalo dairy innovations

Adoption of dairy innovations was measured by the question (have you used any type of dairy innovations). Farmers answering (No) were given a score 1 and those answering (yes) were given a sore 2.

Year of Adoption

Adoption of innovation is a series of adopting different innovations in the field. In order to measure this variable, the respondents were asked about what year they actually started of adopting dairy innovations.

Continued adoption

Continuously adoption of dairy innovations was measured by the question (Are you still using dairy innovations). Farmers answering (No) to this question were given a score 1 and those answering (yes) were given a score 2.

Reasons for non -adoption and discontinuous of Dairy buffalo innovations

Sample respondents were to specify reasons, which lead them to take their decision related to buffalo dairy innovation.

Reasons for adoption of dairy innovations

The respondents were asked what the advantages or why you use buffalo dairy innovations.

Curriculum vitae

20.07.1965	Born in Menoufia Egypt
1971- 1976	Primary school attended in El- Bagour Menoufia
1976- 1980	Preparatory school attended in El- Bagour Menoufia
1980- 1983	Secondary school attended in El- Bagour Menoufia
1984-1987	B.SC. of Agricultural science in animal production “very good” Menoufia University
1989-1990	B.SC. of Agricultural science in Agric Extension and rural sociology "Excellent” Menoufia university
1990-1994	Teaching and research assistant in the department of Agric. Extension and rural sociology
1995	Master degree of agricultural science in Extension and rural sociology, Menoufia University
1996	Assistant lecturer in the department of Agric. Extension and rural sociology
1997	Registration for a Ph.D. in the department of Agric. Extension and rural sociology
1999	Recipient Government scholarship
2000	Study of German language in Goethe institute for three month in Bremen
2001-2004	Registered for a doctoral degree in agricultural science in the faculty of agricultural and horticultural at the Humboldt university of Berlin

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