The present world is experiencing an information revolution, by the rapid advances in research and technology development and transformation of information between generators and utilizers. Agricultural research creates potentially useful perspectives and ideas but it has no inherent value unless its contributions are utilized by farmers and is based on farmers problems. Likewise, extension becomes important only if it helps farmers to organize, empower and communicate and if it acts as an interface between Research and Farmers.

The Synergic Operation of agricultural research, extension education and farmer is called the Agricultural Knowledge Information System (AKIS). Agricultural research and extension are inseparable functions which are mutually reinforcing, with the potential of turning low agricultural output around. While extension must have a continuous flow of reliable information from research to pass on to the farmers, research on the other hand benefits from the information provided by the extension in order to tailor research programmes towards the needs of the farmers. The exchange of ideas, information of resources has often been found to be lacking in the technology systems in most developing countries mainly due to poor linkages (Annor-Frempong, 1988).

The most important aspect of the linkage process is the information flow. The farmer must have adequate and reliable information on various aspects of agriculture and dairy farming which is necessary for him/her to take appropriate decisions. This is where the role of researcher in generating farmer based technology and the role of extension in providing information on technologies
to the farmers assumes relevance. Besides this would enrich the researchers with the needs and farming situations. In accomplishing this task of free flow of information among all the actors of agricultural development, linkages among them will prove vital.

In Farmer-Extension-Research continuum it is essential to ensure that extension and research services remain responsive to farmers' changing needs and opportunities. In this system, Extension has to establish and quantify the technologies recommended by the research system. It should also identify the constraints faced by farmers in their production system. Unless a strong extension organisation and delivery mechanism exist it is difficult to expect speedy transfer and utilization of research based extension messages.

Dairying is an integral part of the Indian agricultural System, providing good economical support to the farmers. In the post-GATT Scenario it is expected to play a very crucial role in the economic transformation of Indian agricultural system. Milk production which was stagnating at 20 million tonnes until 1970, crossed the 30 million mark in 1980 to touch 70 million tonnes in 1997. Today, India is the largest milk producer in the world. Even at a modest growth rate of 4-5 percent, milk production is expected to be around 80 million tonnes by the turn of the century in India. At the same time, demand for liquid milk is rising at a faster rate. At 35.81 million tonnes in 1982, industrial demand was projected to be 90 million tonnes by the turn of the century. A demand-supply gap of 12 million tonnes by the end of 2000 AD is likely.

This higher production is possible through application of improved technologies by the millions of dairy farmers spread throughout the country. It
calls for continuous generation of technologies which are need based and suitable to the farming situations and an effective extension system to process the research output, develop into proper messages and transfer to the dairy farmers, coupled with effective delivery system of various technical inputs and services. An ideal system is to have effective linkages between all the constituent actors of dairy development which includes policy makers, researcher, extensionists, farmers, input suppliers and marketing agencies.

Here arises the need of an efficient agricultural knowledge information system (AKIS) in the domain of Dairying to bring in modernisation and thereby enhance production. With reference to dairying the AKIS may more suitably be named as DKIS i.e. Dairy Knowledge Information System. An understanding of the functions which are to be performed by DKIS is the primary requirement. The research work that is not based on actual situation and needs of the farmers makes little contribution. Similarly, extension work that is not sustained by research results or not oriented towards the client, is of little use. In the absence of effective linkages the process of dissemination of innovations is disrupted, and the effectiveness of research system and its relevance to farmers is reduced.

There is ample evidence to show that the extension workers are often out of touch with farmers' problems and do not attempt to understand the research process (Cerna, et al., 1985). It is also found that the linkage between research and extension is the weakest (Annor-Frempong, 1990). Researchers are sometimes bewildered regarding whose responsibility it is to convey results to extension. The interfaces between each of the systems' major entities are valuable. The main problems of AKIS, such as problems caused by conflicting domains, heterophily gaps, ineffective linkage mechanisms and so forth, occur
at the interfaces. Faulty interfaces lead to failure to transform knowledge and information appropriately, and hence to a system that cannot operate synergically. The management of AKIS interfaces is therefore a crucial task. The linkage mechanism is the device which operationalizes the interface among the actors involved in development (Roling, 1989).

1.1 Statement of the problem

A good number of studies have been conducted in India on Communication Behaviour of Extension Personnel, researchers and farmers and on diffusion and adoption of innovations. However, there are few studies treating researchers, extensionists and farmers under one system i.e. the agricultural knowledge information system (AKIS), where "the persons, networks and institutions and the interfaces and linkages between them, which engage in, or manage, the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, and which potentially work synergically to improve the goodness of fit between knowledge and environment, and the technology used, in a specific domain of human activity" (Roling, 1988). Keeping these facts in view, the present study has been undertaken in the domain of Dairy Knowledge Information System (DKIS) with the following objectives:
1.2 Objectives

i) To analyse the linkages in the Dairy Knowledge Information System (DKIS).

ii) To study the information management in relation to improved practices and innovations in sustainable dairy production.

iii) To study the constraints in the information flow.

iv) To study the role perception of various actors (researchers, extensionist, input suppliers, marketing agency and farmers) in the DKIS.

1.3 Scope of the study

The present study will help to analyse the information management in the DKIS and the patterns of information flow among different components of the system. This study will also bring out the constraints in the information flow that cause the delay in transfer of technologies from researchers to Extension personnel and farmers and feedback from farmers to researchers and factors hindering flow of information from farmers to researchers for development of appropriate technologies. It will provide valuable data to the researchers, extension personnel, administrators and policy makers for proper management of information. It will also help in advanced research on DKIS in the future.
Fig. 19 Model of Information Management in DKIS for Developing Countries
found most important source of communication (Kapoor, 1966; Champawant and Intodia, 1970; Kakoty 1975; Sarkar, 1981; Singh, 1982; Singh, 1989) followed by personal localite channels in the knowledge stage of innovation-decision process (Ernest, 1973; Mohammed and Singh, 1978; Sawant et al., 1979).

At the persuasion stage of the innovation-decision process, face-to-face communication with localite inter personal channels were found relatively more important (Reddy and Singh, 1977; Singh, 1982; Babu and Sinha, 1985). The influence of opinion leaders in the persuasion stage to adopt innovations also substantiate this finding (Katz, 1952; Van den Ban, 1964; Verma, 1970).

At the decision making level, localite interpersonal channels were found more important for simple innovations (Rogers and Pitzer, 1960; Sinha and Parshad, 1966; Singh, 1989) and for technically complex innovations, cosmopolite interpersonal channels were found important (Beal and Rogers, 1957; Singh and Jha, 1965 and Sandhu, 1967).

In general, Indian Studies reported many more channels/sources than those found in the US diffusion studies. Indian studies reported inter personal channels/ sources such as face-to-face communication with family members, rural leaders, seed producers, while US studies mentioned none of these. Roles of electronic and print media were relatively less in India because of relative non-availability compared to USA (Rao, 1981). However, studies in the later eighties showed influence of mass media on Indian farmers as a source of information (Tyagi and Sohal, 1984; Bhagat and Mathur, 1985; Gupta, 1991).
So far no study has been conducted in India, on AKIS perspectives i.e. with a systems approach and synergic functioning of various actors of the system with particular emphasis on user control over the system. Hence, rest of the review is based on the recent developments in information system with emphasis on modelling the system, linkages and flow of information.

2.2 INFORMATION SYSTEM

At a simple and general level a system implies an assembly of parts, connected through processes in ways which form a recognisable whole thing. The term "system" has long been used in descriptions and analysis of what is involved in organising the supply of information and advice to farmers by extension services (Axinn, 1969).

Information systems in agriculture has attained worldwide attention recently. This reflects a broadening interest beyond the usual Research(generation)-Extension (dissemination) - Farmer (utilisation) model which has long served as a basis for viewing the transfer of information in agriculture. Agriculture information systems have become of use in defining and organising research studies into aspects of extension. Therefore, it was felt essential to understand the nature and functioning of information systems in agriculture and the insights that could be derived in particular situations.

The perception of information by various authors differed according to the particular studies and purposes. The word 'information' as used in everyday speech (as in, for example, useful information, valuable information, factual information, reliable information, precise information, true information) does not
occur in statistical communication theory (Cherry, 1957). He identified three levels of information, corresponding to three semiotic levels namely the syntactic, semantic and pragmatic levels and preferred to confine the Wiener-Shannon statistical theory to the syntactic level. The concept of entropy is central to information theory and is a notion of disorder or uncertainty. In this context the definition of information stemmed from randomness or entropy (McQuail, 1975). In theory, while nature promoted uncertainty, information helped to reduce it. This concept of uncertainty has been relied upon by various researchers to define information. Rogers and Kincaid (1981) viewed information as "a difference in matter-energy which affects uncertainty in a situation where a choice exists among a set of alternatives". Rogers (1983) adhered to this definition and regarded information as one of the main means of reducing uncertainty. Checkland (1981) saw information as a distinction which reduced uncertainty and Windahl, et al. (1992) accepted the definition of Rogers and Kincaid (1981).

Information theory (which is concerned only with the statistics of message transmission) could say nothing at all about the meaning of the information for the originator or the recipient, although in the everyday world this is the most interesting aspect of information (Checkland, 1981). Outside information theory, the word "information" is best used to denote a combination of fact with the meaning an observer attributed to it. The Oxford English Dictionary defines information as "knowledge communicated concerning some particular fact, subject or event; that of which one is apprised or told; intelligence, news". This definition needed careful use since it introduced knowledge as largely synonymous with, or at least not adequately distinguishable from, information. The present study distinguished between information and knowledge for reasons
to be explained later. Information is the significance that we give to data; information is related to the context in which data and information are received and to the person who receives it (Hurtubise, 1984). He pointed out that an item of data that told us what we already know is not information. This, however, is questionable; very often the same data may be supplied to a source for reinforcement of an idea or practice in agriculture. Each time the source is exposed to the same data, it acts as information.

Information is an abstract noun, signifying some single fact or datum or set of facts or data, which may be organized or not. Information is transformed into knowledge (often used synonymously for information) through a process of perception, cognition and cognitive mapping and understanding. To make use of the term as a process is "violence to the language" (Wilson, 1987).

Information is a sensory input that maintains or improves the goodness-of-fit between knowledge and the real world (Roling and Engel, 1992). This definition more or less supported the concept of information envisaged by Miller (1953), who referred to information as the occurrence of one out of a set of discriminative stimuli, a stimulus being an influence that is arbitrarily and symbolically associated with something (or state or event or property) and that enables the stimulated organism to discriminate this thing from others. Roling and Engel (1992) argued that deliberate information provision through communication must pay considerable attention to anticipation. This anticipatory nature is a crucial difference between the concept of information and the term as used in computer science.
From a development perspective, information together with its associated technology may be classed as a resource in agricultural production (Rolls, 1990, Antholt, 1992, Zijn, 1994). The backbone of all agricultural endeavours is the transfer of agricultural information to enhance the productive capacity of farmers (Umali and Schwartz, 1994). Progress in agriculture was thus based on information and information transfer is the main function of extension services (Wete, 1991, Moris, 1991). Information is an important production factor, comparable to land, labour and capital (Antholt, 1992). Moreover, it could have a significant multiplier effect on the efficiency and effectiveness with which other production resources are utilised. The definition of information used in this study conforms to the view of information as a resource and thus is oriented towards the definitions of Wilson (1987) and Rolls (1990).

Communication came sharply into focus in extension theories because the exchange of information is seen as the primary process by which extension agencies stimulated change in farming practice (Garforth, 1993). Information transfer was one of the major functions of communication in rural development. A body of information meaningfully stored (for use or retention) within the individual’s memory is defined as knowledge. In development, effective communication caused the sharing of information and made the users of information better decision makers, or learners. These theories differentiate between information and knowledge in the context of farming.

Information is perceived as that entity which is on the "move" (though not as a flow or regular motion), to reach the individuals to add to or modify their knowledge in the context of communication. Knowledge refers to the absorption (often, but not always, by reading), assimilation, understanding and appreciation
of information (Davies, 1994). Much of the experience of extension work led to
the conclusion that as information is transferred from research findings to
farmers we are concerned with a series of transformations by communicators and
users, rather than a "flow" or simple sequence of stages in unchanged
information (Rolls, 1985). Pragmatically, information may be considered as the
means to the end of knowledge (which itself involves other processes and
mechanisms), and which is an ongoing "process feature" of life.

The Oxford Dictionary gives the meaning of system as "an organised or
connected group of objects". It is explained further as "a set or assemblage of
things connected, associated, or interdependent, so as to form a complex unity;
a whole composed of parts in orderly arrangement according to some scheme or
plan; rarely applied to a simple or small assemblage of things".

The concept of system referred to a complex of interdependencies
between parts, elements or components and processes that involve discernible
regularities of relationships, and to a similar type of interdependency between
such a complex and its surrounding environment (Parsons, 1968). He
commented on the benefit of using a systems approach in explaining a social
system, as any regularity of relationship can be more adequately understood if
the whole complex of interdependencies of which it forms part is taken into
account.

A detailed review of the history and methods of science by Checkland
(1981), explained the concept of systems thinking. The crucial problem which
science faced is its ability to cope with complexity; and systems thinking
developed as a response to these problems of complexity. Systems thinking is
based upon two pairs of ideas, those of emergence and hierarchy, and communication and control. Checkland (1981) defined a system as: "a model of a whole entity; when applied to human activity, the model is characterized fundamentally in terms of hierarchical structure, emergent properties, communication, and control" and a sub-system as: "equivalent to system, but contained within a larger system".

In the present study information is conceptualized mainly as a process of communication, involving various information sources. An early study by Newcomb (1953) explained communicative acts in a system context through the A-B-X model, in which interaction or exchange is explained in terms of communicative acts. A communicative act is defined as a transmission of information, consisting of discriminative stimuli, from a source to recipient. This was similar to the view of Jones (1993) who defined information as "the transmission and reception of meaning". It is felt appropriate to narrate the essence of the A-B-X model. Person A transmits information to Person B about something X. There is a core concept of "co-orientation", the simultaneous orientation (both cognitive and cathetic) of A toward B and toward X in an independent manner (Fig. 1).

Thus, the A-B-X transaction was judged as a system, with certain definable relationships between each of the elements, all being viewed as interdependent. A given state of the system was assumed to exist when any such A-B-X communicative act occurs and the act changes the system's state. This was one of the early studies which viewed information transfer (communicative acts) within a systems perspective. The widely adopted Westley and MacLean
Fig. 1 Newcomb's A-B-X model
(1957) model of mass communication and an important study on information dissemination in agriculture by Emery and Oeser (1958) had their foundations in Newcomb's model.

Various research studies conducted in India, maintained that agricultural communication, by and large, followed a systems approach (Singh, 1988). This consisted of three distinctive subsystems: the research system, the extension system and the client system. He suggested that the functions of the client system were the "adoption of innovations" and "feedback". The fact that any subsystem mentioned above may perform the functions of other subsystems, in varying degrees, was not explicitly realised in this model. Yet this realisation was very important in understanding the clients, especially when viewed through a systems perspective. By doing so, it could be appreciated that the client system, to varying degrees, could and does also perform the functions of research and dissemination. This made farmers a multifunctional element of an information system. As a client sub system, farmers were not passively bound to accept and adopt certain innovations, supplied or "offered" by the research or dissemination systems. Agricultural information may be viewed as a system in itself or as a subsystem within a wider information system e.g. of science or food and nutrition.

Jones (1990) used a systems perspective to apply a holistic approach to a relevant defined whole and the activities within it. He emphasized the flexibility of the system as a concept, though in addition to its advantages, this created a degree of vagueness and incertitude. All the above studies, as well as studies by Singh (1970), Havelock (1971), Nagel (1980), Bembridge (1984), Swanson et al. (1984), Ambastha (1986), Beal and Meehan (1986), Bruce
(1989), Arnon (1989), Bawden and Russel (1990), Samantha (1990), Delman (1991) and Roling and Engel (1992), agreed that a system perspective was helpful to a discussion of information transfer in agriculture.

When the linking factor is information, causing intra and intercomponent activities, the result was regarded as an information system. The linkages between components were studied from different perspectives: for example through research utilization, technology transfer, outreach, research-extension continuum, diffusion or communication. Irrespective of the type of linkage, there is one common element, namely "information", that joined together the various components. In fact, it is the efficiency of linkages rather than the efficiency of components that caused the overall level of efficiency of a system (Evenson, 1986). Another justification for this approach would be the issue of rational intervention. The introduction of an item of information led to anticipated and unanticipated consequences for the users. These were contributed by the entities functioning in the system. The activities of these entities and their linkages could be studied more effectively in a system context. The critical aspect of diagnosis in an information system was the analysis of the information interlinkages.

In short, system approach helps to understand a situation in a comprehensive manner, often identifying the "would have lost" elements. A systems view helps in understanding and describing the whole and in predicting and controlling the different parts to make a better whole (Ram Kumar and Rolls, 1995).