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ENHANCING THE CONTRIBUTION OF BUFFALOES TO FOOD SECURITY AND RURAL PROSPERITY IN ASIA

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ABSTRACT

Buffaloes are a conspicuous component of the agricultural landscape and rural environments of Asia, in which they occupy an important socio-economic and ecological niche. Potential possibilities of enhancing their contribution to food security and rural prosperity are discussed in the context of their role in Asian farming systems, distribution, ownership, products and services. Whereas in South Asia buffaloes are valued mainly for milk and secondarily for draught power, in East Asia and South East Asia, the species is primarily important for both beef and draught power. Good progress is being made in China and the Philippines to produce triple- purpose buffaloes (milk, meat and draught power). While the irrigated AEZs are the traditional environments of the species, buffalo populations are expanding into arid and rainfed environments where they are largely owned by the landless and small farmers. Four categories of buffalo production systems are indentifiable: - (i) Rural landless systems, (ii) Extensive systems, (iii) Systems combining arable cropping (tethering, communal and arable grazing systems, and cut-and-carry feeding). and (iv) Systems integrated with tree cropping. Of these, the fourth is underestimated and are associated with significant economic impacts. The strategy for development pathways include *inter alia* the following : priority for increasing buffalo numbers ,institutional support for integrated resource use, improved natural resource management ,targeting research and development of rainfed areas, the application of systems methodologies and interdisciplinarity , feed resources and nutrition ,access to technologies and delivery systems, and improved markets and marketing . Of these, increasing buffalo numbers merits high priority, as also targeting rainfed areas where buffaloes along with small ruminants can serve as the entry point for development and food production. These objectives merit increased institutional efforts, policy framework, resource allocation, research and development initiatives, which together can impact on real benefits to food security and rural communities in Asia.

Key words: Buffalo, farming systems, milk, meat, draught power, production systems, food security, systems methodologies, development pathways.

INTRODUCTION

The buffalo, more than any other ruminant species, is a truly Asian animal. It is part of the natural heritage of Asian farming systems in which it occupies an important socio-economic and ecological niche. It is found in all countries without exception, is distributed widely across all agroecological zones (AEZs) mainly in small farm systems, is multifunctional in its ways, and is very much a conspicuous component of the agricultural landscape and rural environments of Asia.

The fact remains that despite its conspicuous presence, apparent importance and many contributions, there is general neglect of the species in most countries, associated with declining numbers, negligible research and development investments, poor resource allocation, weak research programmes, all of which result in poor productivity and potential role in farming systems. The declining numbers appear to be associated more with the swamp buffalo in South East Asia such as in China, Indonesia, Malaysia and Thailand with sharp negative population growth rates between -1.6 to – 6.5 5 per year . At the heart of this is weak or non-existent policy support and weak national buffalo development programmes for the species whose definition can provide the necessary emphasis and direction.

This paper examines the prevailing contribution of buffaloes in Asian farming systems to food security and rural livelihoods. It alludes to potential opportunities and potential improvements. More importantly, it discusses development strategies that need to be vigorously pursued to enhance increased contribution from buffaloes in the future.

Food security: It is important to be clear about the term food security. Food security provides the link between production and availability on the one hand and potential use on the other. It is a primary objective in the livelihoods and aspirations of farmers, a reason to passionately work on the farm, and provide for a better tomorrow for their families. Several definitions of food security exist, but that of the FAO (2003) is noteworthy as follows:

" *Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food for a healthy and active life* " . This involves four dimensions:-

- Adequacy of food supply or ***availability***
- ***Stability*** of supply, without seasonal fluctuations or shortages
- ***Accessibility*** to food or affordability, and
- ***Utilisation***: quality and safety of food.

Food security is an important element of poverty, and embraces production, supply, processing, distribution and market access. Food insecurity, food deficits or shortages are thus major issues, and addressing ways to ensure that these can be minimised to the extent possible are major challenges that all countries are concerned with. The extent to which these issues can be overcome

Will vary from country to country, and much will depend on the degree of investments on agriculture, food distribution systems, early warning measures, transport and communications. An overriding factor concerns the presence of appropriate policies on food security.

At the small farm level, nutritional and food insecurity problems are very common, and are often caused by the dilemma between the food needs of the farming family and the necessity to sell part of the produce such as rice, maize or native chicken to generate cash income. The stability of rural households is thus put at risk with other resulting difficulties, and ways to minimise these and ensure consistent farm produce are major challenges for small farmers.

An important aspect of food and nutritional insecurity concerns dietary animal proteins. Animal products such as meats, eggs and milk are important sources of concentrated and digestible sources of high quality proteins and energy, and their consumption significantly contributes to good health. These sources supply micro nutrients such as calcium, iron, zinc, and vitamins A, B6 and B12, which are often deficient in cereal-based diets.

Ownership of animals

The ownership of animals is closely associated with food security. This relates to three main socio-economic strategies and benefits:-

(i). *Short term current savings* - this is achieved through the sale of especially small animals (eg. goats, sheep, chickens, ducks and rabbits) to meet immediate and unforeseen household needs, including food

(ii). *Medium term savings* - this serves as reserves to meet cash for childrens` education, and medical and farm needs (eg. buffaloes and cattle)

(iii). *Long term savings* – these acts as an insurance against crop failure, and sale of animals in the event of droughts, famines floods and the like (eg. buffaloes and cattle).

The ownership of animals and the contribution to food security is associated with the distribution across agro-ecological zones (AEZs). The relevance of the ownership is especially pronounced in the less-favored. more fragile semi-arid and arid AEZs. In these areas, climatic conditions, especially of very low rainfall and very high temperatures are extreme and the ownership of animals enables survival of very poor people, associated with which is food security . Examples of such environments are Baluchistan and North West Frontier Province in Pakistan, Rajasthan in India, and to a lesser extent north east Thailand, and the eastern islands of Indonesia. In these situations, the value of ownership of animals and their contributions increases with decreasing quality of the environment.

Some idea of the patterns of ownership of buffaloes is reflected in table 1. It is instructive to note that the landless also owned buffaloes and cattle, and more importantly that both this group and small farmers accounted for the largest share of households (70.1%) and the largest ownership of buffaloes (38.9 %). These same groups are also the poorest of the poor, but continue to provide a substantial proportion of milk through mainly informal marketing systems. The larger farmers will continue to flourish with scope for expansion of the operations due mainly to access to credit.

Table 1. Size and distribution of land holdings and buffalo ownership in India (Govt. of India, 1997)

Types of households	Share in arable land (%)	Size of holdings (Ha)		Share of animal population (%)	
		B*	C*	B*	C*
Landless	21.8	0.0	0.0	2.8	2.4
Marginal (>1 Ha)	48.3	15.4	0.3	36.1	47.1
Small (1-2 Ha)	14.2	18.6	1.4	21.7	24.0
Medium (2-4 Ha)	9.7	24.2	2.7	20.2	16.6
Large (> 4 Ha)	6.0	41.6	7.5	19.2	9.9
Total	100.0	100.0	-	100.0	100.0

* B – Buffalo, C- Cattle

Associated with above is the distribution of buffaloes across AEZs. Table 2 presents some interesting data also from India. While the irrigated AEZs are the traditional environments of the species, there is clear evidence that buffaloes are also expanding into mainly rainfed AEZs. Over a 25 period between 1982-1997, table 2 indicates that the buffalo population growth rate was highest in the arid area. The combined population

growth rate of 5.2% per year for the arid and rainfed areas is over two times that of buffaloes in the irrigated areas.

Trends in table 1 indicate a few observations:

- Buffalo populations are clearly expanding beyond the traditional irrigated areas into the more difficult and less favoured rainfed environments
- This trend also suggests increased adaptive powers of buffaloes
- The largest ownership of buffaloes by the higher proportion of landless and small farmers clearly emphasises the value of the species to the poorest of the poor and the most vulnerable
- Associated with above , the benefits to enhancing nutritional and food security is enormous, and,
- Underlines the importance of targeting development initiatives that can focus on buffaloes and rainfed environments with potential impacts on improved livelihoods.

Advantages of rearing animals: Animals are valued for more than just meat and eggs, and are intimately involved with farming systems and the way of life of farmers. Given the considerable diversity in the types of animals in global terms, it is not surprising that there also exists diversity in the number of products from the animal genetic resources and their contribution to mankind in the developed and developing countries. They are consistently and widely owned by farmers for a variety of advantageous reasons (Devendra, 1983; Chantalakhana, 1990):-

- Diversification in the use of production resources and reduction of Socio-economic risks
- Promotion of linkages between system components (land, crops and water)
- Generation of value-added products (eg. meat, milk, eggs and Skins)
- Income generation, investment, insurance and economic security
- Supply of draught power for crop cultivation, transportation and haulage operations
- Contribution to soil fertility through nutrient cycling (dung and urine)

Contribution to sustainable agriculture, and environmental protection.

- Prestige, social and recreational values, and
- Development of stable farm households.

Products and services from buffaloes: The contributions from buffaloes are not only in terms of food (meat and milk), but also in a variety of non-food products. These include for example, traction and haulage activities, skins and hides, wealth accumulation, insurance against the failure of crops, prestige in the ownership, and also in sports and recreation. In many ways therefore, animals in the developing countries are multifunctional. To further illustrate the latter, table 2 presents the range of products and services from buffalo.

Table 2. Products and services from buffaloes in Asia

Products	Services
Meat (raw, cooked, blood, soup)	Cash income and investment
Milk (fresh, sour, yoghurt, butter, cheeses, ice cream, baby foods)	Security and insurance
Skins (clothes, shoes, water/grain containers, tents, handicraft, thongs etc.)	Prestige in ownership
Horns	Gifts and loans
Bones (handicraft)	Religious rituals eg. sacrificial slaughter
Manure and urine (crops, fish)	Human nutrition – beneficial characteristics of meat and milk
	Pack transport and draught power
	Draught power
	Medicine

Buffalo production systems: Prevailing animal production systems, characteristics and trends in Asia have recently been discussed in detail (Devendra, 2007a). It proposed therefore that the sections following will only highlight the more important issues concerning the subject.

Four categories of production systems are identifiable:-

- Rural landless systems
- Extensive systems
- Systems combining arable cropping (tethering, communal and arable grazing systems, and cut-and-carry feeding); and
- Systems integrated with tree cropping.

Landless systems: The landless systems are of two categories as follows:

(a). Urban and peri-urban industrial landless systems – mainly non-ruminant production

(b). Rural landless livestock production systems

For purposes of this paper, rural landless production systems which refer mainly to ruminants include buffaloes. These involve zero grazing practices and extensive systems that are associated with resource-poor nomads, transhumants or agricultural labourers and seasonal migrations with small ruminants, cattle and camels. They are very common in the arid and semi-arid regions notably Pakistan and India, and also in the Hindu-Kush Himalayan region in South Asia. The movements are annual cycles that are triggered by reduced feed and water supplies, and market opportunities. They are also a way of life for the poor. Two common problems are

overgrazing and environmental degradation due to "slash and burn "for agriculture.

In India, the migrating flocks of goats and sheep are often used overnight to fertilise crop land, and crop farmers pay relatively high prices or give cereals in return for their service. In northern India, this means for example, 2000-3000 goats and sheep folded on 0.2 ha of land costing 1 US$ per 100 animals per night or 60-80 kg of grain in return (Devendra, 1999). In many parts of China, landless rural households often keep poultry and pigs for home consumption and also sale. Similarly, in the rice growing countries in South East Asia and East Asia, landless farmers produce ducks and sell these after feeding on fallen grains and also weeds after the rice harvest. Similarly, dung produced fro buffaloes are often sold and also extensively used for crop cultivation in many parts of India, Pakistan and countries in South east Asia.

(ii). Crop-based systems: mainly mixed farming

The remaining three systems are essentially crop- based and encompass mixed farming crop- animal systems. These systems form the backbone of Asian agriculture, and are especially important in terms of land area involved, extent of poverty, integrated NRM, food security and potential opportunities for increased food production. Diversification and integration of the production resources are common. The sections below give a brief description of the features of mixed farming systems.

Two broad categories of mixed farming systems can be identified:

(a) Systems combining animals and annual cropping in which there are two further sub-types:

- Systems involving non-ruminants, ponds and fish eg. Vegetables- pigs –ducks- fish systems in Vietnam , Rice – maize- vegetables- sweet potatoes – pigs – dairy cattle (China)
- Systems involving ruminants eg, Maize-groundnuts/ soyabean – goats systems (Indonesia), Rice- finger millet- rice – goats (Nepal)

(b) Systems combining animals and perennial cropping in which there are again two sub-types:

- Systems involving ruminants eg. Coconuts – sheep integration (Philippines), Oil palm – cattle and buffalo integration (Malaysia)
- Systems involving non-ruminants eg. Oil palm – chickens integration (Malaysia)

Mixed farming systems are synonymous with crop-animal systems, are varied and integrated with cropping in various ways. Both ruminants and non-ruminants are involved, and the choice of one or more species is dependent on overriding influence of preference, market dictates, potential to generate income, contribution to crop cultivation and livelihoods.

Integrated tree crops-ruminant systems

Integrated systems refer to approaches that link the components to economic, social and ecological perspectives. The process is holistic, interactive, and multi-disciplinary and promotes efficiency in natural resource management (NRM) .The integration of various crops and animals enable synergistic interactions, which have a greater total contribution than the sum of their individual effects (Edwards *et al.,* 1998). Thus for example, the integration of beef cattle with oil palm results in increased fresh fruit bunches (FFB), palm oil, and also beef. Additionally, both ecological and economic sustainability are addressed in a mutually reinforcing manner.

Types of ruminant-oil palm interactions: Reference is made to such integrated systems are especially well developed in East and South East Asia, There are many benefits of crop-animal-soil interactions (Devendra and Thomas, 2002). The following interactions and tangible benefits are common in oil palm:-

(i). Beneficial effects of shade and available feeds on livestock

(ii). Draught animal power on land preparation and crop growth

(iii). Dung and urine on soil fertility and crop growth

(iv). Use of agro-industrial by-products from trees *in situ*

(v). Use of native vegetation and effects on cost of weed control, crop management and crop growth

(vi). Type of animal production systems.

Table 4 gives an indication of the nature of crop-animal interactions involving buffaloes in oil palm systems. The interactions can be positive or negative, depending on the type of livestock and trees, age of trees, and management systems. To ensure compatibility between livestock and trees, the correct choice of species, control of grazing, and also the optimum age of trees when the leaf canopy is out of reach of the animal are important considerations.

Table 4. Main oil palm buffalo interactions (Devendra, 2004)

NO.	CROP PRODUCTION	BUFFALO PRODUCTION
1.	Annual and perennial crops provide a range of crop residues (CR) and agro-industrial by-products (AIBP) which can be used by buffalo.	Buffalo provide DP for land preparation, soil conservation and haulage operations.
2.	The natural herbage between inter-rows of tree crops provides a variety of feeds (grasses, legumes and shrubs) which can be used by buffalo. The average availability is 600 kg DM/ha in oil palm systems.	Buffalo produce manure and urine for the maintenance and improvement of soil fertility.
3.	Tree crops also provide valuable shade for buffaloes which significantly reduces heat stress.	The effective utilisation of the CR and AIBP gives valuable animal products such as meat, milk and DP.
4.	Cropping systems such as alley-cropping and food-feed systems provide additional forages for buffalo.	Animals grazing the herbage control weeds. There are reduced weeding costs (16 – 40%).
5.		Buffalo provide an entry point for the introduction of improved grasses in tree cropping systems (e.g. Guinea grass) and legumes (e.g. Gliricidia) for productivity enhancement in animals with attendant benefits.
6.		The sale of animals, animal products and hiring out buffalo for DP and transportation provide cash for the purchase of fertilisers and pesticides.
7.		The integration of buffalo with crops, and development of silvopastoral systems adds value to the oil palm crop, and can demonstrate increased total factor productivity.

Conducive production attributes and production options

The oil palm environment offers a number of conducive production attributes for integrating ruminants to enhance total factor productivity albeit from both crops and animals. It is pertinent to enumerate these as follows:-

- Forage dry matter availability: 2.99- 2.16 mt / ha for 3 and 5 year old palms reducing to 435-628 kg / ha for 10-29 year old palms (Chen *et al*., 1991).
- 60-70 forage species in young palms , which are reduced by about 66 % in older palms
- Forage categories: 56-64 % grasses, 18-23 dicotyledons, 3-19 % legumes and 2-15 % ferns for 3- 10 year old palms , and 50 % grasses, 13 % dicotyledons, 2 % legumes and 35 % ferns (Wong and Chin, 1988)
- About 72- 93 % of the forages are palatable and of value to ruminants
- Carrying capacity: 2 steers / ha in 3-4 year old palms with average daily gain of about 320g/ /day for a two year cycle to 0.3 steers /ha with over 7 year old palms , and
- The under- storey forage cover presents an excellent area to breed buffaloes to produce numbers for intensive production systems
- The use *in situ* of the many crop residues and by-products from oil palm and the potential for intensification of the systems has recently been emphasized (Devendra. 2009).

Associated with above, stratification and several potential production options are feasible within oil palm plantations are as follows:-

- Breeding ruminants (buffaloes, cattle, goats and sheep) for production systems
- Growing ruminants for meat production
- Zero grazing systems (beeflots, goats and sheep)
- Rearing ruminants to use the available oil palm by-products
- Rearing ruminants for grazing and controlling weeds
- Rearing ruminants for draught and haulage operations
- An entry point for development of integrated NRM and sustainable production systems
- Value addition and total productivity returns. and
- A hedge for possible reduction in the price of crude palm oil.

With specific reference to South East Asia, there are four important implications:-

(a). Indonesia and Malaysia together own about 8.4 million hectares or about 82 % of the world land area under oil palm. The use of 10 % this land area alone, involving both young and old palms on a 50:50 basis can

accommodate about 966,000 buffaloes, with concurrent benefits to meat production and food security

(b). The additional buffalo populations will provide an important source of draught power for transportation and haulage operations, with much savings on tractors and fossil fuel requirements

(c). In Malaysia, there is evidence that utilising buffaloes to transport FFB from the field to collecting centres , increased farmers` income by as much as 30 % (Liang and Rahman, 1985).

(d). The land areas under oil palm provide good opportunities for carbon sequestration through more widespread use of grasses and tree legumes, and improved forage management practices, with resultant decreased carbon atmospheric emissions and global warming.

(iii). Rangeland-based systems

Rangeland – based systems are found mainly in the semi-arid and arid regions of South Asia and China. These areas are unimportant for buffaloes. Sparse vegetation, containing mainly native grasses and shrubs are characteristic of this area. These however are important sources of feeds. In Pakistan, some 65% of the total land area, from altitudes of 0->4000m is rangelands, and it is estimated that 60% and 5 % of the total feed requirements of small ruminants and large ruminants respectively are met by the rangelands (Devendra *et al*., 2000). Three major concerns about rangeland-based systems are the need for strategies to use of common property grazing lands, communal management of these lands, and drought feeding.

Future of buffalo production systems: These production systems are unlikely to change in the foreseeable future (Mahadevan and Devendra, 1986; Devendra, 1989), however, there will be increasing intensification and a shift especially from extensive to systems combining arable cropping, induced by population growth. Specialisation and intensification are inevitable, but will need to be done gradually, based on successful experience and without undue risks. The principal aim should therefore be improved feeding and nutrition, and maximum use of the available feed resources, notably crop residues and low quality roughages, and various leguminous forages as supplements.

It has been suggested that small mixed farms will remain predominant in Asia in the foreseeable future, in which crop-animal systems will see continued intensification and important growth, and that animals, in addition to production, will continue to enhance the natural resources base (Devendra, 2002). Pro-poor strategies, social and effective development policies are therefore needed that can address increased contribution from these farms to the food chain within an enabling economic environment to spur agricultural development.

The development of sustainable and productive crop-animal systems in the future will however require an increased commitment to interdisciplinary research with a farming systems perspective that can focus on whole-farm situations and priority AEZs. The evolving scenarios will simultaneously need to address several major issues such as nutrient flows, waste disposal, overgrazing, all year round feeding systems, and zoonosis and policy issues.

Sstrategy for development and pathways: The strategy for development and pathways to achieve should address a number of issues, and these are reflected in Figure 1. They include a focus on the following *inter alia*:-

- Priority for increasing buffalo numbers
- Institutional support for integrated resource utilisation
- Improved natural resource management
- Targeting research and development of rainfed areas
- The systems approach and interdisciplinarity
- Feed resources and nutrition
- Access to technologies and delivery systems, and
- Improved markets and marketing

The development pathways include the following *inter alia*:-

- Based on constraint analyses through community-based participation, focus on the priority needs to improve animal production systems
- Improve diversification through the appropriate mix of animals with annual or perennial crops to intensify production
- Reduce transaction costs related to capital, inputs and markets
- Increase investment in infrastructure
- Improve credit facilities and risk management strategies
- Create increased access to information, improved technologies and delivery systems that can potentially impact on total production increases, socio-economic benefits, improved livelihoods and sustainable development
- Strengthen empowerment to include informal training at various levels
- Encourage wider use of systems methodologies to address R and D issues
- Promote the formation of cooperatives, farmer organisations, focus groups and farmer- managed revolving funds to enhance decision making and resource planning. The successful Anand model of India`s "Operation Flood "involved making farmers shareholders of the whole chain of marketing and processing of milk, is worthy of emulation, and,

- Promote pro-poor initiatives that are consistent with income growth, socio-economic benefits, improved livelihoods and self-reliance.

(Figure 1 here)

Increasing buffalo numbers: Increasing buffalo numbers in the future is an urgent priority. Between the two South Asia and South East Asia sub-regions, the problem is much more serious concerning swamp buffaloes in thelatter. In South East Asia, sharply declining numbers are associated with the following reasons in many countries:-

- Poor breeding programmes that are associated with weak or non-existent breeding policies
- High extraction rates of animals for slaughter , resulting in increasing imports of beef, and
- Inadequate understanding of the role and value of the species in specific production systems

One significant development in China (Liang *et al*., 2004) and the Philippines (Cruz, 1995) is crossing the swamp buffalo which is valued for meat and draught with such dairy breeds such as the Murrah and Nilli Ravi from India and Bulgarian buffalo. The main objective of such crossing is to create a triple purpose animal which is valued for meat, milk and draught .Progress in this direction has been impressive with overall improved performance in such traits as body size, growth rate and milk production. However the stability of the crossbreds and sustainability of the breeding programmes to produce buffalo numbers remains to be established

Targeting the development of rainfed areas: Among the development strategies, targeting the rainfed areas in Asia is justified by three reasons:-

- Inadequate availability of arable land
- The need for more animal numbers , and
- Increase productivity from buffaloes to match the projected human needs for animal proteins.

These circumstances thus force a need to look beyond the use of arable land in mainly irrigated areas, and to focus much needed attention on the more difficult rainfed areas. Consideration must therefore be given to improved use of these areas and the management of natural resources therein.

Of particular relevance is the fact that buffaloes, along with small ruminants (Devendra, 2007b), can serve as the entry point for development of the rainfed environments.

In Asia, rainfed areas (marginal/less favoured + arid lands + forests and woodlands) accounted for 83.1% of agricultural lands compared to 16.6% favored land. Marginal and arid lands alone constituted 48.5% of the total area. Additionally, about 63 % of the rural population was found in the former compared to only 37% in the favored areas. It is of interest to note in this context that in 1993 in India, 42 % of the rural poor lived in low potential rainfed areas, 16 % in irrigated areas, and 42 % in high potential rainfed areas (Fan and Hazell, 2000).

The rainfed areas are those that have also been bypassed by the "Green Revolution" official support and greater development emphasis is now necessary for these regions, similar to that of the irrigated areas. Good examples of this, and where there is now a push for rural growth to redress the imbalances between the cities and rural areas are the vast Indo- Gangetic plains in northern India, and the western regions in China .With improved technological interventions, increased resource use, and opportunities for improved NRM and animal production these areas can produce more food in the future (Devendra, 2000).

Application of the systems methodologies and interdisciplinarity: Research and development concerning NRM, soil-plant—animal interactions and the environment is complex and involves many disciplines. Systems perspectives, systems approaches and interdisciplinarity enable overcoming some of the major constraints in the predominant mixed farming systems in Asia. The systems approach requires multi-and interdisciplinary interpretation of the different components of the system and biophysical environment, identified through detailed analyses of the constraints, needs and opportunities. These ensure that the individual components, interactions and contributions can focus on the whole system.

The methodology for systems research is distinct and follows several sequential steps: - (i). Site selection. (ii) Site description and characterisation (Diagnosis), (iii) Planning of on-farm research, (iv) On-farm testing and validation of alternatives, (v) Dissemination of results, and, (vi) Impact assessment. The systems approach needs to be backed by a few other important requirements:-

- Recognition of the importance of interdisciplinary participatory approaches
- Formulation of research programmes that have community-based participation to set a common agenda and create ownership. It should involve both production and post-production systems
- Programmes that are needs-led, and have institutional and structural commitment
- Establishment of effective participatory planning, inter-institutional coordination and collaboration, research management, dissemination of information, and resolution of feedback issues
- Long term commitment to achieving impacts, and,
- Training in agricultural systems and systems methodologies at various levels.

Cooperative development: Cooperative development is largely dependant on the capacity of farmers to be self-reliant to benefit from the economies of scale, bargaining power, competitiveness in agri-business, as well as reduced market risks. In China for example, cooperatives are very limited, and a nationwide need for their establishment to overcome natural and market risks has recently been suggested (Chuanmin and Falla, 2006). It is of interest to note that in December 2006, the Chinese Government enacted the Farmers Specialist Economic Cooperatives Law to stimulate the rural economy. Fully developed cooperatives are dynamic, contribute significantly to rural development, and can enable small farm systems to respond to market dictates.

Conclusions: In the panorama of Asian farming systems, buffaloes play an important multifunctional role that is associated with a significant contribution of livelihood systems. The products and services are numerous, the more important of which is milk, meat and draught power, explained in part by the presence of more dairy-type animals in South Asia and meat and draught types in East Asia and South East Asia and their distribution. Despite their importance in the farming systems and rural communities, institutional efforts, resource allocation, research and development are minimal, as a consequence of which their potential contribution has not been fully realised. In East Asia and South East Asia, buffalo numbers are rapidly decreasing. Important development strategies include more concerted breeding programmes and policy support for rapidly increasing animal numbers to support production systems and maximise the contribution of the species.

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