



**SUSTAINABLE**

**DEVELOPMENT**

**Impact and Incidence**

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# Mixed Farming Practices in India and Abroad

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## INTRODUCTION

Food is the most important need for sustenance of human life. In the human history, people are always motivated to search and seek food. Throughout history, food has acted as a catalyst for societal organization, development, and expansion. The main requirement of a country is to attain and sustain food security. Only a stable agricultural sector ensures a nation of food security. Agriculture is the cultivation of land and breeding of animals and plants to provide food, fibre, medicinal plants and other products to sustain and enhance life. About 2 million people worldwide still depend on subsistence agriculture. Over the last few years, radical change in the agricultural sector of developing countries has been the spread of mixed farming. Agricultural households in developing countries face substantial risk of farm income fluctuations. Farm income is subject to yield and price risk, both of which are significant because of the dependence of farming on weather. Risk consideration are more important for poor farmers because their income is low and formal insurance arrangements are seldom available. (Kurosaki). Mixed farming provides farmers with an opportunity to diversify risk, promote greater bio-diversity, allow intensified



farming, and make the best use of crop residues and to maintain diversified agro ecosystem. Mixed farming is also an important strategy to increase the income of resource poor farmers.

India has a long agricultural history. Agricultural sector occupies a vital position in the overall economy of the country. 54.6% of the population is engaged in agriculture and allied activities and it contributes 17% of the country's gross value added (2011 census). It offers raw materials to agro-based industries, generates employment, provides market for industrial products, contributes to national income etc. and more important is provision of food for the ever increasing population. Relevance of agriculture is thus, not relegated but demands a mechanism to sustain it against all modern challenges.

Agriculture in Kerala is characterized by a diversity of crops like food crops, non-food crops, seasonal crops, annual crops and perennial crops etc. which makes agriculture of Kerala a distinct flavor. An important source of state income is contributed by agricultural sector. Mixed farming in Kerala has gained momentum nowadays for the purpose of meeting family requirements and profiting from both enterprises. Almost every household has a home garden where subsistence crops and cash crops are grown, livestock is reared and fodder, fuel, timber are produced.

### **SIGNIFICANCE OF THE STUDY**

Mixed farming is defined as a system of farming in which both crop and livestock farming are combined for the purpose of meeting family requirements and profiting from both enterprises. The case for integrating these two is based on the premises that bye-products from the two systems are used on the same farm. Farmers engaged in mixed farming are

economically better off than others because uncertainties in crop production can be reduced by integrating livestock with that of crops. Livestock is an important source of income and employment in rural areas. They contribute to household income and provides full time occupation with better utilization of human resources which have otherwise zero opportunity cost. The role played by women as an important human resource cannot not be neglected. Women contribute their energy in farm operations and livestock management besides their household activities. Mixed farming also serves the purpose of retaining biodiversity, recycling of energy, food security to family, healthy surrounding etc. Mixed farming provides farmers with an opportunity to diversify risk, promote greater bio-diversity, allow intensified farming, and make the best use of crop residues and to maintain diversified agro ecosystem. Mixed farming is also an important strategy to increase the income of resource poor farmers. Farmers practicing single activity are considered under more risk than those practicing mixed farming under uncertain environment and market situation. So it is considered that animal's rearing with crop cultivation will affect significantly the farm income of farmers. The present study tries to analyze existing practices of mixed farming in different parts of the world especially in India and Kerala.

## REVIEW OF LITERATURE

Devendra et al. (2002) in their article Crop animal interaction in mixed farming system in Asia observed that there is a well-developed integration of crop and animal production in mixed farming system of Asia. There exists complementarities between the two optimum resource efficiency can be seen in mixed farming system. Pomi Shahbaz et al. (2017) in their study



Mixed farming and its impact on farm income, A study in district, Faisalabad, Punjab Pakistan analyzed about the impact of mixed farming on farm income of farmers and they concluded that mixed farming was a better option than the single activity as it generates more income. Indranil Biswasey et al. (2008) in their study Livestock in mixed farming A leveraging asset for inclusive rural development in India highlighted the gap for smallholders livestock producers to gain livelihood of mixed farming in more effectively. It is argued that this gap be addressed by expansion of veterinary services in public sector, downsizing of dairy technology, standardization of dairy products like milk, meat, eggs etc. Subadra (2007) in her study Economics of mixed farming in Kerala, it was found that mixed farming practiced by respondents in Trissur and Palakkad district indicated complementarities of dairy and crop enterprises. Dairy income had considerable a share in enhancing farmers' income along with income from crop production. Regarding gender dimension, it was found that majority of unpaid work was done by women. Farmers face many production and marketing constraints like inefficient resource use, low productivity, unorganized nature o of farms, etc.

### **OBJECTIVES OF THE STUDY**

The objective of the study is to analyse the existing practices of mixed farming in different parts of the world especially in India and Kerala.

### **SOURCE OF DATA & METHODOLOGY OF THE STUDY**

The study is based on the secondary data purely. The journals, article, web links, previous studies, books have been used as source of information...

## FORMS OF MIXED FARMING

According to FAO, mixed farming systems can be classified in many ways – based on land size, type of crops and animals, geographical distribution, market orientation, etc. The categories are, (FAO, 2001)

- On-farm versus between-farm mixing
- Mixing within crops and/or animal systems
- Diversified versus integrated systems

The modes of farming refer to different degrees of availability of land, labour and inputs, ranging from plenty of land to a shortage of land. The modes are characterized by Schiere and De Wit (1995) as expansion agriculture (EXPAGR, plenty of land), Less external input agriculture (LEIA), High external input agriculture (HEIA) and new conservation agriculture (NCA, a form of land use where shortages are overcome by more labour, more inputs and keen management).

### On-Farm versus Between-Farm Mixing

On-farm mixing refers to mixing on the same farm, and between-farm mixing refers to exchanging resources between different farms. On-farm mixing occurs particularly in LEIA where individual farmers will be keen to recycle the resources they have on their own farm. Between-farm mixing occurs increasingly in HEIA systems – in countries such as the Netherlands it is used to mitigate the waste disposal problems of specialized farming. Crop farmers use dung from animal farms, a process that involves transport and negotiation between farmers and even politicians. Between-farm mixing also occurs at the regional level – in the store cattle systems of the United Kingdom and the United States, animals are raised in one area to be fattened in another area where plenty of grain is available.

In tropical countries also, manure may be transported from livestock farms to farmers and vegetable cropping areas where manure is in short supply.

### **Mixing within Crop and/or Animal Systems**

Mixing within crop and/or within animal systems refers to conditions where multiple cropping is practiced, often over time, or where different types of animals are kept together, mostly on-farm. Both these systems occur frequently though they are not always apparent. Within-crop mixing takes place where crop rotations are practiced over and within years. For example, a farmer has a grain-legume rotation to provide the grain with nitrogen or a potato-beet-grain rotation to avoid disease in the potatoes. Plants can also be intercropped to take maximum advantage of light and moisture, to suppress weeds or prevent leaching of nutrients through the use of catch crops. Examples of mixing between animals are found in chicken-fish pond systems where chicken dung fertilizes the fish pond; in beef-pork systems where pigs eat the undigested grains from the beef cattle dung; or in mixed grazing such as cow-sheep mixes to maximize biomass utilization or to suppress disease occurrence

### **Diversified Versus Integrated Systems**

Diversified systems consist of components such as crops and livestock that co-exist independently from each other. In particular, HEIA farmers can have pigs, dairy and crops as quite independent units. In this case the mixing of crops and livestock primarily serves to minimize risk and not to recycle resources. Integration is done to recycle resources efficiently. It occurs in mixed ecological farms of temperate countries (here called the mode of new conservation agriculture, NCA), but also in mixed, relatively low input farms of southern and south-western



Australia with grain-legume-sheep mixtures. Integration occurs most often, however, in LEIA farming systems that exist in many tropical countries where products or by-products of one component serve as a resource for the other – dung goes to the crops and straw to the animals. In this case the integration serves to make maximum use of the resources. Unfortunately, these systems tend to become more vulnerable to disturbance because mixing of resource flows makes the system internally more complex and interdependent. Grazing of livestock under plantation trees such as rubber, oil palm or coconut is a form of crop-livestock integration that is often found in Southeast Asia. Experiments in Malaysia with cattle and goats under oil palm showed better oil palm bunch harvest and comparable results were found where goats fed under rubber trees. In rubber and oil palm plantations in Malaysia, the integration of livestock to utilize the vegetative ground cover under the tree canopy increased overall production and saved up to 40 percent of the cost of weed control. Similarly, sheep helped to control weeds in sugar cane fields in Colombia. This suppressed the costs of herbicides, reduced the cost of weed control by half and provided additional income from meat production (FAO, 1995a). This also occurs where cows graze under coconuts

### **MIXED FARMING SYSTEM IN DIFFERENT COUNTRIES**

Mixed farming system adopted in abroad, India and Kerala are elaborated in this section to get an idea about prevailing practices and conditions under various regional contexts. Mixed farming in one form or the other is prevalent all over the world. During the pre-world war-II period, there were extensive areas devoted to subsistence crop and livestock farming located in East Europe, the Soviet Union, the Middle East and Mexico. After world war-II there has been an increasing pressure on

peasants to collectivise their petty holdings. This has happened especially in socialist countries of Eastern Europe. (Mnadape, 1988). Due to drastic changes in agricultural sector, the subsistence mixed farming covers a very limited part of global arable land. In Asia, mixed farming systems are the backbone of Asian agriculture (Devendra, 1983). These integrated farming systems involve several subsystems including crops, animals and fish. Synergistic interactions have a greater total effect than the sum of the individual effects (Edwards et al, 1988). The integration of crop and animal production is well developed in the farming systems of Asia, particularly those in small-scale agriculture. There is marked complementarity in resource use in these systems, with inputs from one sector being supplied to others.

Mixed farming – or Commercial Crops and Livestock, as it was described by Whittlesey – is found throughout Europe, from Ireland in the west through central Europe into Russia. It is also found in North America east of the ninety-eighth meridian, reaching its apogee in the Corn Belt: outliers are to be found in other areas of European settlement, in the Argentine pampas, South East Australia, South Africa and New Zealand. In Indonesia, the three-strata forage systems (TSFS) is a way of producing and conserving the feed requirements of cattle and goats without degradation of the environment. In dry land farming areas such as eastern Indonesia and South Asia the system combines production of food crops, including maize, groundnuts, cassava and pigeon pea, with shrubs and trees to supply year round feed for stock (Nitis et al, 1990). Rice-fish-duck system is also seen in Indonesia. The success and rapid expansion of the rice-fish system in particular (and the inclusion of ducks in Indonesia) is an example of the efficiency of integrated natural resource use and its economic benefits.



In United States mixed farming is the second most extensive type of agriculture, and covers a large part of eastern half of the country. It extends through Ohio, Indiana, Illinois, Iowa and Nebraska on the north, and Virginia, Tennessee, Georgia, Oklahoma and much of Texas on the south. A small area in Pacific North-West also has mixed farming. Crop/livestock farming systems are predominant in South East Asian countries. Animal production contributes a variable but significant proportion of farmers' income. Animal production involves both ruminants and non-ruminants and variety of systems integrated with crops. Systems vary as a function of agro ecological zone and intensity of farming operations.

There was a well-balanced and comprehensive mixed farming system which enabled Denmark to become one of the leading exporters of foods of animal origin like butter, cheese, bacon and poultry meat. The success story of Denmark (Prabhakaran and Raut, 1980) is clearly illustrative of the fact that the small 35 holdings are likely to be economically more viable than large holdings. Realizing this, utmost priority is given to integrate rural development in the current Five year plan and under this the implementation of special programmes particularly suited to the small and marginal farmers are receiving greater attention. An example of a complex, well-managed mixed farm can be seen in Cornwall, UK. The MFS farm considered used to have a simplified crop rotation with crops that can be combined, some winter, some spring sown, which were undersown with a new ley. Given the wet, maritime Cornish climate, grassland combined with livestock production are key to make sustainable use of the geographic advantages for future success. In terms of technical innovations, grazed fodder beets are seeded in spring, allocating low producing leys identified by weekly measurement. Male dairy calves for rose



veal make use of secondary products from the primary dairy production, to get an additional and different income stream. Looking for synergies between crops and livestock could reduce workload and increase farmers' quality of life. Globally, mixed farming systems produce the largest share of total meat (54%), and milk (90%). Regionally, the mixed farming systems of the OECD countries and Asia provide by far the largest share of these products, but also in sub-Saharan Africa, West Asia and North Africa (WANA) and Central and South America, mixed farming is the main system for smallholder farmers. Resource use in mixed farming is often highly self-reliant as nutrients and energy flow from crops to livestock and back. By definition, such a closed system offers positive incentives to compensate for environmental effects ("internalize the environmental costs"), making them less damaging or more beneficial to natural resource base.

### **Mixed Farming Systems in India**

In India, the importance of mixed farming was realised even in early independence period and ICAR during 1941-46, initiated scheme for simultaneous investigation and demonstration of mixed farming in 4 provinces of undivided India (U.P, M.P, North West frontier, Pakistan). At all he places, mixed farming unit remarkably gave better results. North Indian region was considered as the best region for mixed farming. (Mandape. 1988). In India, small-scale mixed crop – livestock farming is the common and most dominant form of animal husbandry. For small and marginal farmers, animal husbandry based on family labour and residues and by-products of crops grown on their own land continue to be a substantial source of income and employment. There is considerable spatial and temporal variation in the mixed crop livestock systems in India. A major

feature of these systems is the great diversity and complexity in the crops grown and livestock species raised and these systems are constantly evolving over time. Agro climatic, technological and socioeconomic factors account for spatial and temporal variations. Demand for livestock products is increasing fast due to population and income growth, urbanization and change in tastes and preferences. Livestock products also have a higher income elasticity of demand compared to cereals, pulses, fruits and vegetables.

Indian farmers have a long tradition of integrated farming, primarily involving large ruminants like cow and buffalo and small ruminants like goat and sheep. Crop-livestock, crop-fish, agro forestry and other forms of integrated farming systems can help to provide both additional channels of household income and opportunities for value addition. The integration of crop and livestock production is a factor which strongly influences the sustainability of a farm. In rural areas, the people are primarily concerned with the cultivation of food crops, and their interest in livestock rearing depends mostly on the time available after having paid sufficient attention to their main occupation. The highland mixed farming system incorporates the cultivation of a range of cereals, legumes, tubers, fodder, fodder trees and livestock. In the more remote 38 areas, where mineral fertilizers are very costly or unavailable and distance to markets is prohibitive, the flow of nutrients to cultivated land is generally originating from grazing or cutting of fodder trees from woodland areas at higher altitude. In more accessible areas, the opportunity for successful vegetable production, particularly potatoes, can result in highly intensive system of commercial production. Similarly, in the hills of Himachal Pradesh there has been a large expansion in horticulture, particularly the apple orchards. Generally, ruminant livestock are important parts of



the system as they provide draught power, milk, manure and cash income.

The rain fed mixed farming system is not supported by any large irrigation system but in many instances relatively small areas irrigated from tanks reduce vulnerability to drought and permit dry season cropping. This traditional tank based supplementary system has been further enlarged in recent decades by the use of tube wells. Crops grown within the system include wheat, barley, vegetables, and fodder crops in the cooler northern areas, while maize, sorghum, Finger millet, vegetables, chickpea, pigeon pea, green gram, black gram and groundnuts are more common in the warmer climates of Southern India. In smaller areas, soybean, rapeseed, chilli, onions and sesame are grown mainly as cash crops. Double cropping is possible only where irrigation is available. The coarse grains, pulses and oilseeds are grown on the upper parts of the landscape. Some fruit trees such as mango are grown in home gardens. Livestock are important parts of the farming system which supports the largest share of cattle, sheep and goats in the region and they usually provide the major part of the farm family's cash income, particularly through sales of adult animals or young stock, since most areas are too remote for commercial milk production.

Indian agriculture is characterized by mixed farming involving a system of combining crop production with one or more of the livestock enterprises like rearing of cattle, sheep, goat, pigs and poultry as well as fishery, bee-keeping, sericulture, etc. Although in India farming is not commercialized to a large extent, it remains that farmer has to make decisions regarding his business of farming, with a view to attaining maximum income. The income may not be maximization of net profit in the usual sense, but it can be assumed that he would like to maximize farm income by which he can maintain himself and



his family. The decision of enterprise mix on a farm will be conditioned by overall welfare of the family.

### **Mixed Farming Systems in Kerala**

Agriculture is the main occupation of Kerala. Coconut and paddy are the main crops the name "Kerala" signifies 'land of coconut' Kerala accounts for 1.18 per cent of the geographical area of the country and supports 3.9 per cent of its population leading to a very high degree of land use. The farm models in Kerala are unique and essentially revolving around homestead farming system. Main cropping systems are: Coconut based, Rice based, Plantation based, Arecanut based, Spices based, Mixed farming, Homestead farming, pure crops of Rubber, Coffee and Tea.

### **Mixed Farming Systems in Kerala**

Mixed farming systems in Kerala represents a typical land use pattern, which maintains a variety of crops and trees along with other allied enterprises viz., livestock and poultry spread around houses and operates at different levels of intensification. Different types of crops, livestock, poultry and/or fish production is carried out mainly for satisfying the varied needs of farmers and a complex interaction exists among soil, plants, animals, other inputs and environmental factors. Integration of livestock with crops is peculiar to Kerala, where the most preferred animal is cow. Mixed farming system has been one of the survival strategies of the traditional farmers of Kerala since quite long time. Mixed farms represent a promising land use system and are common in Kerala, where the average size of farm household is small. The area around the house or farmyard is normally planted with a wide assortment of crops, which not only offer shelter and privacy, but also contribute diversity and

quality to the diet of the farm family. The three basic types of farming systems followed in Kerala (John and Mercy, 2003) are (a) coconut based system comprising a number of intercrops like pepper, arecanut, cocoa, clove, banana, ginger, turmeric, tubers, fodder crops, pineapples, pulses, oilseeds, vegetables, green manure crops and cover crops, (b) rice based system in low lands with single or two crops of paddy, summer vegetables, pulses or oilseeds with or without aquaculture components and (c) homestead farming system including a large number of components like perennials, food and fodder crops, livestock, fishery, poultry, apiary etc.

It is found that coconut based farming system is a time-tested practice in Kerala. Due to the availability of sufficient interspaces in coconut garden, a variety of crops are grown as intercrops. With the integration of livestock component in homesteads it became a necessity to raise quality fodder crops. The declining land availability made the farmers to try fodder cultivation in coconut gardens to sustain a viable dairy unit. By product utilization in coconut based farming system is in its maximum and is sufficient to meet the fuel requirements of a farm family. In both Pokkali and Kuttanadu rice ecosystems, integrated farming with rice, fish, livestock and poultry has been developed. Studies by Salam et al. (1992) about farming system have helped to evolve a homestead model for coastal uplands of southern Kerala under irrigated conditions. Crop-livestock integration with one crossbred cow and its calves or two female goats and kids or ten birds of poultry reared on kitchen waste imparted sustainability to the system. Pepper was trailed on coconut, arecanut and jack and no separate standards were provided.

Mixed farming by raising fodder grasses such as hybrid Napier or Guinea grass along with leguminous fodder crops

such as *Stylosanthes* has been found to be profitable. Raising the above crops in one hectare of coconut garden can support three to four dairy animals. The animals supply large quantities of cattle manure when applied to the soil will improve its fertility status. This sort of mixed farming will improve the yield of the palm.

In coconut, various subsidiary enterprises could also be integrated to generate more employment and income for the family. One such viable and compatible system has been developed at Central Plantation Crops Research Institute, Kasargod in an 1.2 hectare area with the following enterprises such as (a) Cultivation of grasses in the interspaces, (b) Dairying with 5-6 milch animals, (c) Poultry birds (100 number broiler birds each per batch), (d) Japanese quails (100 number), (e) Rabbits (10 female and 4 male), (f) Aquaculture (625 m<sup>2</sup> surface area), (g) Agriculture with Indian bees and (h) Biogas unit (3 m<sup>3</sup> area). Pokkali is a unique saline tolerant rice variety that is cultivated using extensive aquaculture in an organic way in the water-logged coastal regions, Pokkali fields is spread in about 27000 ha in the coastal area of Ernakulum, Alappuzha, Trichur and Kannur districts. (sasidharan, 2012) Rice & Prawn are rotationally grown in these fields. Income from prawn yields compensates the losses from rice cultivation. It is considered as sustainable system. The merits of this mixed farming practice are no way interfere with seasonal rhythm, components well mingle, accretion rather than depletion in soil fertility, ecologically sound, environment friendly and socially acceptable. It is possible to integrate other components such as coconut, banana, yams and other crops on the bunds and the livestock such as fish, ducks, and buffaloes. One acre paddy field can additionally hold 2000 fish fingerlings, 300 broiler ducks, 1-2 buffaloes, 20 coconut palms on the bund, 40 banana plants, 20-



40 yams, Single line fodder of 80m length. The complementary effects on land preparation are manuring, weeding, plant protection etc. Economic benefits are cost of production reduced; Increase in yield, multilevel integration increased the returns 3-4 fold. Ecological benefits are reduction in use of agricultural chemicals, Improvements in soil conditions, recycling of agricultural wastes, perceptible improvement in soil biological properties etc.

## CONCLUSION

India is a country where, over 70% of the population still lives in rural areas and agriculture and allied farming activities is the key source of income for about 60% of the population. The development of mixed farming has the potential for poverty eradication. The livestock enterprises are complementary to crop production; so as to provide a balance and productive system of farming. Mixed farming satisfies the requirements of sustainability by being productive, ecologically sound, stable, economically viable, and socially acceptable.

## REFERENCES

1. Rai Saroja (1994), "Agriculture in Sikkim with special reference to the mixed farming of La-Chen and La-chung valleys of North Sikkim", *Ph.D Thesis*, North Bengal University.
2. Subhadra. M (2007), *The Economics of mixed farming in Kerala*, PhD Thesis, Mahatma Gandhi University.
3. Singh Nand Akhila (2006), "Employment and income generation from various enterprises in mixed farming system and economic analysis in District Ballia of U.P." *Ph.D Thesis*, V.B.S Purvanchal University, Jaunpur.
4. Shahbaz Pomi Boz Ismet, Haq Ul Shamseer, Khalid Bin Umer (2017), "Mixed Farming and its impact on farm income: A study in district, Faisalabad, Punjab Pakistan," *IJRDO-Journal of agriculture and research*, Vol-3, Issue-8,PP-2

5. Kurosaki T (1997) "Production risk and advantages of Mixed Farming in the Pakistan Punjab", *The Developing Economies*, XXXV-1,28-47.
6. Fami Shabanali (2006) "Relationship between different characteristics of rural women with their participation in mixed farming activities", *Journal of Agriculture, Science, Technology*, Vol-8,107-17.
7. Mandape Krishnaji Manohar (1988) "A multidimensional study of mixed farming among small and marginal farmers", *PhD Thesis*, Indian Agricultural Research Institute.
8. Thakar Rajendrasinh. F (1992), "A Critical study on role of farm women in mixed farming productivity with special reference to Kheda district of Gujarat state, *Ph.d Thesis*, Gujarat Agricultural university.
9. Thakker Bharat. N. (2001), "A comparative study on mixed farming among marginal, small and medium tribal farmers of south Gujarat," *PH.D Thesis*, Gujarat Agricultural University
10. Gill Singh Gurmikh, (1981) "Study on economic potentials of mixed farming economy of the Punjab." *Ph.d Thesis*.
11. Onima. V.T (2014), "Development of scale to measure attitude of farmers towards mixed farming," *Anand Agricultural University, Thesis*.
12. Roy Maniklal, (2009), "Mixed farming amongst resource poor families in West Bengal-Gender Perspective," *Ph.d Thesis*, National Dairy Research Institute.
13. Waghmare Narhari Maruti, (2004), "An economic analysis of mixed farming in the scarcity area of Western Maharashtra," *Ph.d Thesis*, Department of Agricultural Economics, Ahmednagar.
14. Sasidharan. N.K & Padmakumar. K.G, (2012), *Rice production systems of Kerala*, KAU, Regional Agricultural Research Station, Kumarakom.