CHAPTER - 2

REVIEW OF LITERATURE

The main objective of this section is to review the theoretical information available from similar and related studies. The theoretical approach discussed pin points the issues and concerns in sustaining agriculture. It is studied in the global perspective, in the Indian context and in the Kerala scenario in detail. An attempt is also made to review the past studies which are relevant to farming systems especially the rice based cropping system in the coastal ecosystem of Kerala. Studies on different types of integrated farming practices are also reviewed.

2.1 Developments in Agriculture

The concept of land encompasses a variety of functions that typically get classified into the categories of the environment, economics and society. In terms of economics, land can be viewed as scarce space for locating economic production activities, infrastructure and dwellings, as productive soil that provides organic and inorganic materials for agriculture, as a store of assets and resources and as a source of aesthetic value and amenity services. On a social level the ownership of land acts as a source of prestige and an organizing principle for socio-economic relationships. As one of the three traditional primary inputs (land, labour and capital), land was used as an inclusive term for the natural environment, covering entities such as oceans, atmosphere or solar energy. Everything that owes its usefulness to human inputs was classified under capital, and those things that owe nothing to it were classified as land. For the Physiocrats, economic surplus was attributable to land.
Agriculture is a new production or generation because it brings land and labour into physical existence. This view of the special role of land is very nicely explained by what Kenneth Boulding (1992) referred to as a ‘food chain theory’. To him, ‘The farmer produces more corn than the farmer and his family alone can eat. This results in a surplus. If this is fed to cattle it produces meat and milk, which improve human nutrition and perhaps enable the farmer to produce more food.’ An economy’s maximum level of output is consistent with the amount of arable land available for cultivation and a given state of technology (Gilbert, 1987). Adam Smith considered the produce of the land as the principal source of the revenue and wealth of every country (Smith, 1776). For Smith agriculture was more productive than manufacturing because it has two powers concurring in its production, land and labour, whereas manufacturing has only one (labour). Division of labour was the main element of productivity increase.

Ever since our ancestors gathered for ploughing and planting our numbers have marched in lockstep with our agricultural prowess. Each advance from the domestication of animals, irrigation, wet rice production, led to a corresponding jump in human population. Every time food supplies stagnated, population eventually leveled off. An influential discussion was initiated related to population growth and resource scarcity sparked by Malthus’ influential Essay on Population (Malthus, 1798). He devised a theory of population growth in which he explained poverty as a race between growth of population and changes in the means of subsistence, thereby focusing attention on the limited supply of land. As the labour force increases, extra food could be produced only by extending cultivation to less fertile soil or by applying capital and labour to land already under cultivation, with diminishing results because of the so called law of diminishing returns. In this essay he stated that population growth would
be checked or stopped by various factors. His argument was essentially that population grew geometrically whereas food production and resource provision grew at a slower arithmetic rate. He concluded that because of this more and more peasants and subsistence farmers would live poorer and poorer lives until some checks came into place. He proposed that there would be positive checks, which raise the death rate; and preventative ones, which lower the birth rate. In 1943 as many as four million people died in the ‘Malthusian correction’ known as the Bengal Famine. The oft repeated central tenet of Malthusian theory is that the growth of human population always tends to outstrip the productive capabilities of land resources.

Malthus was criticized for his failure to acknowledge, among other things, variations in the quality of land, the specification of a time horizon, the availability of other resources, and improvements in technology and in production processes. The alternative viewpoint came from Esther Boserup who suggested that human innovation and technological advances would allow food production to keep up with population growth (Boserup, 1965). She argued that when population density is low enough to allow it, land tends to be used intermittently even though not frequently with gaps in time to allow land to recover and with heavy reliance on fire to clear fields and fallowing to restore fertility. It is only when rising population density compelled the cultivators to keep out from the practice fallowing the fields, cropping system moved towards annual cultivation. This reduces fertility and to deal with this people expanded efforts at fertilizing, field preparation, weed control, and irrigation. This process of raising production at the cost of more work at lower efficiency is what Boserup describes as ‘agricultural intensification’ or the gradual change towards patterns of land use which makes it possible to crop a given area of land
more frequently than before. Boserup focuses her attention on exploring the role of population as an independent variable that influences the development of agricultural technology which, in turn, shapes the productive capacity of resources. In contrast to the Malthusian idea of 'invention-pull' population growth, Boserup proposes 'invention-push' agricultural change. To Boserup, advances in agricultural technology such as the plow, irrigation or fertilizer cannot be seen as independent or exogenous inventions.

The insight provided by Boserup was a powerful stimuli to researchers dealing with agriculture beyond the confines of economics who initiated agricultural intensification round the globe. Agricultural intensification in the twentieth century represented a paradigm shift from traditional farming systems, based largely on the management of natural resources and ecosystem services, to the application of management techniques and engineering to crop production. The intensification of crop production in the developing world began in earnest with the Green Revolution. Beginning in the 1950s and expanding through the 1960s, changes were seen in crop varieties and agricultural practices worldwide. The production model, which focused initially on the introduction of improved, higher-yielding varieties of wheat, rice and maize in high potential areas relied upon and promoted homogeneity: genetically uniform varieties grown with high levels of complementary inputs, such as irrigation, fertilizers and pesticides, which often replaced natural capital.

As per the neo-classical production function approach to growth and development, output is a function of inputs. More output can be produced by increasing the quantity of inputs or changing the mixture of inputs.
Green Revolution belongs to the second type of approach. Its emphasis has been on increasing production and productivity and believed in the 'trickle down' effect of growth. The trickle down in economic growth refers to the probable effect of transmitting benefits from top strata to the poorest or lower strata of the society while implementing the strategies of achieving higher economic growth.

The Green Revolution is credited, especially in Asia, with having jump-started economies, alleviated rural poverty, saved large areas of fragile land from conversion to extensive farming, and helped to avoid a Malthusian outcome to growth in world population. Between 1975 and 2000, cereal yields in South Asia increased by more than 50 percent, while poverty declined by 30 percent (World Bank, 2007). Over the past half-century, since the advent of the Green Revolution, world annual production of cereals, coarse grains, roots and tubers, pulses and oil crops has grown from 1.8 billion tonnes to 4.6 billion tonnes. Growth in cereal yields and lower cereal prices significantly reduced food insecurity in the 1970s and 1980s, when the number of undernourished actually fell, despite relatively rapid population growth. Overall, the proportion of undernourished in the world population declined from 26 percent to 14 percent between 1969-1971 and 2000-2002 (FAO, 2009).

In the case of India, the Green Revolution started at first in the late 1960s. With the success of this first wave of the Green Revolution, India attained food self-sufficiency within a decade by the end of the 1970s (Fujita, 2010). However, because it confined only to wheat crop and in northern India such as Punjab, it failed to raise income in the vast rural areas of the country. The second wave of the Green Revolution, however,
reached India finally in the 1980s. Since it involved almost all the crops including rice, which is a very important staple food in eastern and southern India it covered the whole country, it was able to contribute to raise rural income and alleviate rural poverty in the whole country. Thus the second Green Revolution was essential for the history of Indian economic development. Green Revolution in Kerala came as part of the national agenda, the result of a deliberate attempt by the central and the state governments to increase food production through the introduction of High Yielding Variety seeds and the increased use of chemical inputs like fertilizers and plant protection materials and agricultural practices of high productivity.

Despite that success, in the post Green Revolution period, investment in agriculture dropped off dramatically into the mid 2000s (Herdt, 2010). However, the need for continued investments in agricultural innovation and productivity growth is as important today as it was in the early years of the Green Revolution. Low income countries and lagging regions of emerging economies continue to rely on agricultural productivity as an engine of growth and hunger reduction. However, sustaining productivity gains, enhancing smallholder competitiveness, and adapting to climate change are becoming increasingly urgent concerns across all production systems.

The high cost of external inputs together with a low farm price of rice made paddy cultivation uneconomic in Kerala. As a result, paddy cultivation has been shrinking into a high- cost, low productivity regime in the state. It has raised so many issues on the relevance of the new technology and the search for different strategies which are cost effective
as well as eco-friendly, sustainable agriculture. The search for sustainable agriculture has arisen from the growing multi-dimensional criticisms leveled against Green Revolution (Shepherd, 1981). The Green revolution technology adopted in Kerala in tune with the national agenda was inappropriate owning to the unique agro-ecological situations prevailing in these places (Santhakumar and Rajagopalan, 1995). Narayanan (2003) and Lal (1983) observed decreasing production in areas where high external inputs have been consistently used over long periods.

2.2 Sustainable Farming

Sustainable crop production intensification, when effectively implemented and supported, will provide the ‘win-win’ outcomes required to meet the dual challenges of feeding the world’s population and saving the planet. This will allow countries to plan, develop and manage agricultural production in a manner that addresses society’s needs and aspirations, without jeopardizing the right of future generations to enjoy the full range of environmental goods and services. One example of a win-win situation that benefits farmers as well as the environment would be a reduction in the overuse of inputs such as mineral fertilizers along with increases in productivity.

Examining different techniques for agricultural sustainability, Ikerd (1990) points out that it should involve framing the concept of agro-ecosystem developed by Conway (1985) and Altieri (1987). According to World Commission on Environment and Development (WCED, 1987) extreme popular definition of sustainable development is ‘a process of change’ in which exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are in harmony and satisfy current human needs and aspirations without jeopardizing the future potential for satisfying them.
Ecological degradation and the emerging ecological crisis triggered the first global thinking on sustainability issue with the publication of ‘Limits to Growth’ by Club of Rome in 1972 (Meadows et.al. 1972). However the first attempt of this thinking came with the publication of ‘Silent Spring’ by Carson (1962) who warned about environmental consequences of the indiscriminate use of modern chemical pesticides, fungicides and herbicides. The pioneer thinking about the relationship between environment degradation and population pressure and unrestricted use of common property resources to degradation came with the publication of the ‘Tragedy of the Commons’.

Schumacher (1973) was one of the ‘green’ thinkers who put forward the idea that ‘small is beautiful’ and warned of the finiteness of resources. Since then the environmental concern to farming and development became the central thinking.

Sustainability in farming and development is one of the most hotly debated issues in recent years. McRae et.al.(1990) emphasized that sustainable agricultural systems are designed to use existing soil, nutrient and water cycles and naturally occurring energy flows for food production that would make a farm more ecologically and economically diverse and self reliant. They also pointed out that a lot of information gaps exist in our present knowledge about these farming systems, particularly, the cycling of nutrients.

2.3 Integrated Farming

Overexploitation of natural resources may have only short term gains as this could often lead to ecological degradation no longer sustainable by man. The integrated farming paradigm is claimed to be an eco friendly alternative to the proven setbacks of Green revolution inspired agricultural technologies (Padmakumar et.al. 2002).
Integrated farming system that depends on natural processes can convert organic waste of one farming enterprise into useful bio products. Asia is considered to be the cradle of integrated crop-livestock-fish farming. The system helps to diversify the income base of poor fishermen and small farmers (Sinha, 1986). The potentials of the integrated farming technology for transforming existing traditional farming systems into more sustainable system have been highlighted by Lightfoot et al. (1996). In Thailand, elevated ridges made in wetland areas are utilized for growing crops, while the intervening channels are extensively used for fish culture.

Integrated Agriculture-Aquaculture (IAA) systems represent one potential avenue towards sustainable forms of smallholder farming (Dalsgaard et al., 1997). Sustainable smallholder farming is indicative of the concern that in future current farming practices might endanger the continuity of farming systems. This concern expresses environmental, economic and societal demands on farming systems. The increase in food demands, changing consumer preferences and degrading resources in farming will continue to pose new challenges (Dixon et al., 2001).

Nie and Wang (1981) studied the relationship between rice and fish and found that both benefit from each other. They called this “mutualistic association” and this has provided the theoretical basis for expansion of rice-fish culture in China. Since then rice-fish culture techniques have been improved and the problems caused by the changes in rice agronomy and the destructive applications of chemicals and fertilizers have been partially solved.

Li (1988) explains the techniques and methods of rice-fish culture that have emerged in China since 1979 and this includes three types of rice-fish culture systems viz. rotational rice-fish farming or fish culture in rice fields during the winter fallow, summer fallow or during both seasons;
mixed rice-fish farming, i.e. fish culture intercropping in one or two consecutive rice crops; and rice-fish culture in rational and concurrent rice farming polders which depend on the local agro climatic conditions, water supply, soil fertility and availability of fry.

Country overviews on this system of farming have also been provided for Bangladesh (Arce, 1985), China (Li 1988), India (Ghosh, 1992), Indonesia (Ardiwinata, 1957), Korea (Kim et al., 1992), Malaysia (Ali, 1988), the Philippines (Fedoruk and Leelapatra, 1985), Thailand (Little et al. 1996) and Vietnam (Dela Cruz et al. 1992). An extensive bibliography on diverse aspects of fish culture in rice fields has been compiled by Fernando (1993). Technical details on essential lay or modifications for bunds, trenches, water inlets and outlets etc. to make the rice field suitable for fish have been described by Caapistrano and Luna (1992).

Fedoruk and Leelapatra (1992) observed that in Thailand the integration of rice and fish was increasing despite several setbacks it faced in the recent past, with the introduction of high yielding varieties of rice and use of pesticides. The integrated farming technology has become an appropriate method for replenishment of nutrition and environment for sustainable operations and resource management to support healthy human life in Bangladesh (Mazid and Hussain, 1996).

Huat and Tan (1980) studied rice-fish culture in South East Asia and observed that the yield of rice increased by 15 percent with the introduction of fish. The excreta of fish and remnants of supplemental food increased the fertility of soil. The income obtained from the sale of fish, however, compensated the losses if any in rice production. The introduction of herbivorous fish controlled weeds and reduced weeding labour costs. He was of the view that since there are extensive areas of irrigated rice fields
in Asian countries there is immense scope of expansion by introducing fish culture.

Analyzing data from rice fish integrated farming experiments conducted in different situations, Lightfoot et al (1990) inferred that intensifying mono cropped rice might lead to a decrease in soil microbial biomass and therefore soil fertility in the long run. They also observed that integrated rice fish system offered possibilities of increasing rice yields by as much as 15 per cent.

Halwart (1998) has made a comprehensive review of the trends in rice-fish farming system globally and described the phenomenal growth and expansion of this traditional practice in the Peoples Republic of China. While assessing the prospects of rice-fish integration, Halwart indicated that out of the 148 million ha of global area under rice, India stands first with 42.3 million ha followed by China having 33.0 million hectares. He observed that there has been a steady increase in area under rice-fish integration in Peoples Republic of China.

Dutta (1981) estimated that although India has 2.3 million hectares of deepwater rice plots where fish integration is readily possible only a very small fraction of the area is put to this practice. Ghosh (1988) agreeing with this, opines that mono cropped areas under high monsoon precipitation are also potential areas for utilization as fish/prawn culture systems during the summer fallow period, particularly for raising prawns.

Maiti and Chakraborty (1994) studied the economic viability of paddy-cum-prawn culture under mono and dual culture systems in the coastal saline fields of West Bengal and observed that dual culture of paddy and prawn exhibits a higher benefit-cost ratio, although the yield of paddy did not differ significantly in mono and mixed culture systems.
Ghosh (1992) revisited the different works of fish farming in rice fields in India and observed that mono crop rice fields under high monsoon precipitation in deep water rice fields are ideal zones for rice-fish integration. Subramanian (1988) reviewed the scope of increasing production through rice-fish integration in the south western states of India and reported that the low lying fresh water rice fields are suitable to raise two crops of rice and fish, followed by a third non-cereal summer crop in a year. A systems approach to farming development and productivity enhancement of rice, founded on eco technologies and recycling technologies has been highlighted by Swaminathan (2003) to counter the fatigue of Green revolution.

The Kuttanad Water Balance Study (1988) estimated that 20,228 tonnes of chemical fertilizers and 485 tonnes of pesticides are applied every year in Kuttanad. Anilkumar et. al. (1995) indicated how continuous monocropping of rice in Kuttanad has changed the soil texture and its organic status of rice soils. In water logged and light textured soil percolation rate like the one in Kuttanad, apart from loss of added Nitrogen from fertilizer, the loss of the native soil nitrogen through the percolating water was assumed in this study leading to poor fertilizer use efficiency.

Pillay (1997) reviewed the economic and social dimensions of aquaculture management and stressed the essential need for ensuring the social and environmental viability along with its economical benefits to ensure sustainability of integrated farming practices.

Utilization of coastal rice lands for farming of fish/shrimps is an age old practice in Kerala. Vannucci (1986) made an extensive review on this practice of utilization of coastal mangrove habits for sequential farming of fish and prawn in the Pokkali rice fields of Kerala, popularly known as Chemmeenkettu. In this system, the decayed supplement of straw after the
rice crop is utilized efficiently as food materials for prawns. In these fields rice is cultivated during the low saline phase and shrimps reared during the high saline phase. She has indicated that this farming model where shrimp seeds naturally entering from the coastal sea are trapped and cultivation has been mutually beneficial and ecologically efficient.

Based on experiments conducted in the paddy fields, George et al. (1986) found that long term culturing of penaeids in the paddy fields, in general, does not contribute to increased weight. On the other hand short duration culture of one month is sufficient for getting larger shrimps. According to them the paddy fields are not merely a trapping mechanism but they also provide an active and suitable biological environment for the life and growth of these shrimps. Thus a certain amount of culturing also is involved in this process.

Jose et.al. (1987) has traced the recent trends in selective stocking of commercial species of prawns for increased profits. Mary Vijaya, (1998) made a comparative evaluation of different prawn culture systems in Pokkali lands of Ernakulam District in Kerala and found that prawn yield in traditional methods were comparatively lower than that of improved methods, where selective stocking of high valued prawn species are now practiced.

Sasidharan and Sekharan (1996) studied the cultivation practices of paddy in Pokkali rice-fish systems, wherein sprouted seedlings are planted on mounds during the monsoon season. These authors have inferred that it was the brackish water inundation during summer months that facilitated natural weed control in such systems. The practice of harvesting only the panicles of rice leaving behind the stubbles in these fields is intended to provide habitat for the prawn juveniles during the succeeding seasons. Chandrika (1996) observed that *Bacillus sp.* isolated from sediments of
Pokkali fields inhibit growth of pathogenic bacteria and can help to reduce incidence of microbial diseases that cause high mortality in shrimps.

Sreenath et. al, (2000) showed that in India 80 per cent of the shrimp production comes from small and marginal holdings and the traditional Pokkali farms of Kerala accounts significantly in its contribution. Chandramohan et.al. (1999) studied various aquaculture practices in Pokkali fields of Kerala and observed the relative benefits of integration of rice, fish and prawns in this system.

2.4 The Economics of Farming

Tan and Khoo (1980) in their study on integration of fish farming with agriculture in Malaysia estimated that fish farmer’s income from fish culture constituted 22 to 60 per cent of farm income in single cropped area of rice and four to nineteen per cent in double cropped area. They concluded that fish formed a significant part of the total income of at least 60 per cent of tenant farmers interviewed.

Sinha (1979) conducted a study on cost and returns of paddy cum prawn culture at Lembecherra fish seed centre of Tripura state. According to him, fish culture paddy fields not only yielded an additional income but also augmented productivity of paddy. In another study on integrated rice-aquaculture, Dube (1995) observed that, through fish-crop integration, the production cost could be reduced to almost one third. Due to synergistic effect of fish on paddy, paddy yield was reported to increase by 10 percent.

Ganeson et.al. (1991) studied the role of duck cum fish culture as additional component in small holding rice farming system in Cauvery delta region of Tamil Nadu and reported a higher net profit in mixed farming as compared to the prevalent rice-rice –pulse cropping system. Introduction of duck –cum-fish culture as a component in mixed farming
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was demonstrated to yield attractive returns and additional labour days to the tune of 144 man days over the conventional cropping system.

Sadhu and Mahajan (1985) used Cobb-Douglas type of production function to estimate the elasticity of output with respect to inputs in paddy cultivation. Value of paddy yield was the dependent variable, while the four independent variables selected were cropped area, human labour, bullock power and value of yield increasing technology comprising fertilizers, manures and working expenses. The coefficients of land and yield increasing technology were positive and statistically significant. The coefficient of human labour emerged negative, which may be attributed to the excessive employment of labour. The four variables caused about 95 per cent of the variations in paddy output. The analysis of production functions revealed a positive and significant relationship between land and output. The elasticities of labour emerged similar to that in the pooled analysis of all paddy farms.

Joseph (1982) analyzed resource use efficiency of paddy farms of Kuttanad and found that labour cost especially weed control constituted the largest expenses followed by fertilizers. The analysis showed that total cultivation expenses per hectare of paddy cultivation were higher in lower Kuttanad compared to upper Kuttanad. Operation-wise break up showed that gap filling and weed control formed the largest expenses followed by fertilizer and its applications. Input-wise study of the cost of cultivation revealed that human labour use per hectare was the most important input cost amounting to about 45 per cent of the total cost. Regression analysis showed that some of the regression coefficients were significant.

Purushan (1987) appraised the economics of traditional prawn farming in brackish water fields of Kerala and found that the integration of paddy and prawn could almost double the profit as compared to traditional
farming of rice. High yielding varieties of rice has been reported to be less resistant to pest and diseases and demand heavier use of chemical fertilizers and non – judicious application of plant protection measures has been attributed to be one of the reasons for escalation in cost of cultivation (Narayanan, 2003).

The sustainability of the traditional system of rice-shrimp rotation has been highlighted by Nasser and Noble (1991) who compared prawn culture in seasonal fields and perennial ponds in Vypeen, Kerala and found that prawn production per hectare per month was higher in seasonal fields than perennial pond and this has been attributed to be absence of predatory fishes and non-occurrence of soft prawn disease.

Comparative study on different prawn culture in Pokkali lands of Ernakulam district (Mary Vijaya, 1998) found that prawn yield in traditional methods were comparatively lower than that in improved method. Farm income, family business income, family labour income and benefit cost ratio were substantially higher in the improved method as compared to traditional method.

2.5 Issues and Concerns in Farming

Jose (1979) studied social issues that have contributed to the breakdown of the age old rice farming practices in Kuttanad. A major factor that has led to this has been implicated to the distortion of traditional labour relations. The emergence of a labour market and the rise of labour militancy due to unionization have also been implicated as factors that rendered intensive rice cultivation uneconomical.

Muraleedharan (1981) in his article on “Resource use efficiency in rice cultivation in low lying lands of Kerala” observed that inputs such as human labour, bullock labour and fertilizers were not efficiently used. Narayanan (1994) observed that the tenancy reforms of the 1960 and the
subsequent fragmentation of the land are the most important factors that have led to the deterioration of rice cultivation in Kuttanad.

Several authors have identified the environmental degradation of Kuttanad consequent to rice centric approaches adopted in Kuttanad. Abraham (1980), Kannan (1979) and Ambat Babu (1992) reviewed the backlashes of development programme in Kuttanad and observed that almost all the engineering interventions to promote infrastructure facilities for rice cultivation were ineffective in the long run. Padmakumar et al. (2002) have shown that the developmental interventions were not only ineffective but were also positively counterproductive as most of the interventions have further resulted in escalation in cost of production of rice.

Krishnakumari Amma and Alexander (1990) showed that by adopting high yielding varieties of seeds and improved methods of cultivation, although rice yield could be raised by 70 per cent during the green revolution phase in Kuttanad, the benefit cost ratio changed marginally, indicating that factors other than productivity have greatly undermined the increase in the profit margin. According to these authors, the greatest inflationary element in the cost of production of rice that has undermined increase in productivity has been the cost of labour and its decreasing productivity.

Radhakrishnan (1983) conducted a study on the economics of paddy cultivation and its impact on production in the rice granaries of Kerala in Palaghat, Alleppey and Trichur district and showed that the relative as well as absolute profitability in paddy cultivation has declined considerably after the mid seventies. He further observed that the low profitability of paddy cultivation has led to a decline in paddy land prices and shifting of land away from cultivation.
Thomas (1993) through his study on prawn farming in Ernakulam district of Kerala provided some insights on the major constraints in prawn production. Most important constraint was the lack of finance for the adoption for the new technology. Non availability of prawn seed was another problem faced by prawn farmers. He suggested that more hatcheries should be set up by the state and Central governments to augment the supply. Institutional financial assistance should be extended to the prawn farmers including the landless.

2.6 Yield Gap in Rice and its Determinants

Many studies have identified yield gap by defining it in different ways. IRRI (1977) Estimated The Yield Gap Ratios In Rice Production During The 1975-76 Kharif Season. He observed farmers’ technical competence to be high when the gap ratio was low and vice-versa. High yield gap was reported in states like Bihar and Orrisa. This was attributed to the fact that while the demonstration plots were situated in irrigated areas, rice at the farms were generally produced under rain-fed conditions.

Davidson and Martin (1965) surveyed the variations in yields on farms and at experiment station for different crops, including rice, in Australia. The yield gap between farms and experiment station was observed to vary according to the cultivation season. During good years, the yield at experiment station was found to increase more rapidly than the yield on farms within the same district. This was mainly because the farmers were more interested in maximizing their profits by limiting their investment, while the experimenters only aimed at maximizing yield and had no cost constraints.

For the purpose of the study it is important to analyze different aspects of farming. An in depth literature review was conducted to analyze the features and advantages of integrated farming systems suitable for
coastal rice ecosystems. Although the comparative advantage on the biological front was established by various researchers, an in depth study was warranted to find the economic viability and feasibility in typical coastal Kerala conditions. The study envisages an enquiry on to the economic efficacy of farming systems practiced in the coastal ecosystem of Kerala.
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