KeAi
CHINESE ROOTS
GLOBAL IMPACT

Journal of Digital Economy

INTEGRATED FARMING SYSTEM: THE ROAD WAY TO SUSTAINABLE AGRICULTURE

Dr. K. Sentamilselvan,

Professor,

Dr. J. Anand ,
Associate Professor, Department of Management studies,SRM Valliammai Engineering College, Chennai.

Abstract

This paper deals with role of integrated farming system in achieving Sustainable Agriculture. It outlines the features of integrated farming system and integration of subsystems and linkages of different enterprises in farming system. This paper makes a special note on advantages of integrated farming system towards Sustainable Agricultural practices. Also, this paper examines the suitability of integrated farming system models for various agro- climatic zones of Tamilnadu. This paper concludes with some interesting findings.

Key Words: Agricultural, suitability, agro- climatic zones and multinational companies

Introduction

The green revolution agriculture has lost its validity in the developed countries like USA. However, the multinational companies of the developed countries concentrated much on production and distribution of chemical inputs. It could be noted that in the context of increase in population growth, the chemical input agriculture as the derivative of green revolution is desired in countries like India. There is a debate over organic farming,. Tough , it is environmentally, ecologically and human and consuming animal point of view, organic agriculture is desired, the problem of production of adequate quantity of food through organic farming is questionable today, because experiments arein limited area. In the context of globalization and rapid dissemination of new technologies, it is possible to practice integrated farming system through organic farming principles. It is evident from the work of Govindan, R., K.

N.Chinnaswami, B. Chandrasekaran, M. N. Budhar and J. Price (1990) that farmers can sustain their income through integrated organic farming system since they engage themselves in production of various crops, livestock etc.,

Need for integrated farming system

The green revolution agriculture with chemical inputs could lead to progressive deterioration of the soil and contamination of both surface and ground water. It could be noted that natural nutrients of soils are lost when fertilizers are applied improperly. As per the report by Swift, M., and Wommer, P.F., (1993) the uncontrolled usage of fertilizer and pesticide and other phytosanitary products in agriculture may cause a buildup of residue in soil and consequently to human and other living beings getting affected by accumulation of toxic substances.

Ecologically destructive agricultural practices associated with the modern agriculture entails the risk of desertification. It is estimated by some analysts that desertification in India has affected one-eighth of the population namely about 120 million people. It could be noted that the so called green revolution, high yielding varieties that require heavy chemical inputs and water have replaced inter cropping and genetic variety by mono-culture, creating new vulnerability to crop failure due to pest or unseasonal rain. As per the report by Velu, R., (1987) the dwarf variety produced less organic matter and it results in loss of soil fertility. It is argued that such loss of organic matter and fertility does not occur in integrated farming systems.

Soil organisms are considerably affected by the deposition of chemical substances in the soil. It could be noted that earthworms are sensitive to different salts, particularly sulphate of ammonia which is commonly present in fertilizers. It is evident from the work of D. Pearlberg (1980), that earthwormsplay an important role in maintaining the natural fertility of soils, aidingdecomposition of organic wastes. Any benefit derived from this application of chemical fertilizers is lost by the destruction of earthworm.

It could be traced from the work of D. Pimental (1989) that soil organisms such as earthworms, termites and ants influence the rate of soil turnover, mineralization and humidification of soil organic matter, soil texture, infiltration and the water retention capacity of the soil. Further, mechanized ploughing, mono-culture and indiscriminate use of agro- chemicals adversely affect the soil organisms which results in soil degradation and loss in crop productivity.

According to Lal, R., (1988) the top soil is lost, genetic diversity is eroded and toxic and non-recyclable agricultural wastes that get deposited in the soil

damage the environment. As per the report by Zhang, J.H., S.W. Tan, X.Y. Liu, and F. Hong, (1988), soils of a region have a natural balance of various ingredients according to the requirements of plants which have evolved in that region and that balance is destroyed by the application of chemical inputs.

In integrated farming systems, the application of bio-fertilizers and organic manures is desired. Sharma, B.K., M.K. Das, and D.P. Chakkraborthy (1985) reported that the continuous application of organic manures increases soil organic carbon content and reduces the oxidation stability index and ultimately improves the quality in soil organic matter and soil fertility. As per the report by Robert C. (1978), the application of farmyard manures in integrated farming system can increase the yield of crops as that of inorganic fertilizers.

The importance of integrated farming system can be realized in terms of application of organic method of production of crops. It could be noted that fowls fed on organically raised food are better nourished and organically raised fodder is desired by cows and calves. Animals fed on organically raised food are more productive, fertile and have stamina and have a longer working life. According to Dhaliwal, G.S., and B. Singh (1993) organically raised food is better for improving the quality of human life and health.

The application of synthetic chemicals to control pests, insects, weeds and fungi enhances crop productivity. But their excessive use threatens the health of human beings and other living organisms. It has been found that most of the insects, pests and diseases of viral, bacterial and fungal originaffect high yielding varieties. It is evident from the work of Lv. S.S. and C.P. Huang (1988), that in order to protect those crops, various pesticides are applied in large quantities. Almost all pesticides are toxic in nature. Hence, indiscriminate usage of pesticides may leave toxins in food grains, fodder, vegetables, meat, milk and milk products apart from they being absorbed in soil and water.

In integrated farming systems, various bio-control measures could find their application. It could be observed from the work of Vincke, P., and J.C.
Micha, (1985) that integration of rice and fish culture can improve the plant height and yield by decreasing pest and disease incidence. This is because the fish consume weeds, insect, pests and soil borne pathogens.

It is evident from the work of Mohammed Ali, R. Siddeswaran, S. Jaganathan, S. Muthusamy andS. Subramanian (1984) that controlled water supply and the herbivorous feeding habit of many fish species in intensive rice-cum-fish culture offers the opportunity for biological weed control. The practice of integrated farming system is desired today. It has number advantages over the

conventional farming systems. It could be noted that in the process of crop production, some of the organics are left as waste materials and such waste materials, when left as such for long periods, pollute the environment on decomposition. In the case of integrated farming system, waste materials are effectively utilized by linking appropriate components and utilizing the by-products as organic manures. Similarly, adopting bio-control measures can help in preventing pollution of soil, water and atmosphere. In areas where piggery is a major activity, dumping of pig dung gives out huge quantity of unwanted gas and pollutes the atmosphere in the long run. In integrated farming system the pig dung is used in the biogas unit to produce bio-energyfor the utilization of lighting, lifting water from the underground sources and for running incubation unit of the poultry farm etc. Thus integrated farming system helps in avoiding environmental pollution in the long run.

Composition of Integrated Farming System

In the case of rice fish-poultry farming system, poultry manure can be used as complete manure for fish ponds. It is evident from the work of Ayyanan, M., A. Chellakumar, V. Tamilmani and C. Udayasoorian (1991) that recycling the wastes of dairy cow and poultry birds increases the value ofnutrients added to the soil. The poultry waste, when applied to the fish pond,in addition to increasing the soil fertility status, also serves as additional feed for the fish, ultimately leading to increase in fertility status of the pond and fish yield. Besides, the left over or spilled feed by the birds also serve as nutrient inputs. Hence, the integration of fish culture and poultry rearing is said tolead to greater efficiency in resource utilization and to provide additional income to the farmers.

In integrated farming system, recycling of organic waste with poultry manure application improves the physical properties of soil. Ravikumar, R.V. and K.K. Krishnamoorthy (1983) have shown that application of poultry manure and farm yard manure led to higher yields of rice and ragi. Aruna Rajagopal (1994) reported that, in integrated farming systems basal applicationof rabbit excreta increases yield and nitrogen content of plant parts and the addition of a side-dressing of ammonium sulphate can increase both yield and nitrogen content further. Integrated farming system establishes its stability in the form of recycling of waste materials along with its produce. By recycling their own material at the farm level, the farmers can reduce the cost of
production, which enables them to increase the net income of the farm as a

whole.

In the case of the conventional farming system, a massive level of inorganic fertilizers is applied. There is every possibility of soil and environment becoming polluted. Once when soil and environment are polluted, the productivity of land would automatically be reduced in the years to come. In integrated farming system, organic supplementation through effectiveutilization of byproducts of linked components as manures is possible and thus it can certainly provide an opportunity to sustain the potentiality of the production base viz., soil for much longer period.

In integrated farming system, every square centimeter of land is effectively utilized. Growing of perennial fodder legume tree along the borders and water courses is a recommended practice in integrated farming system. This practice not only helps in supplementing legume fodder, but also enriches soil nutrient by fixing atmospheric nitrogen. In the cropped land also,integrated farming system envisages intensification of cropping by including legume fodder like cowpea either as second tier or as third tier in the system. These practices will certainly relieve the crisis of non-availability of quality fodder to the animals. In integrated farming system, by linking agro-forestry appropriately, the production level of fuel wood and industrial wood can be enhanced without detrimental effect on crop activity in the field level. Thereby integrated farming system helps to solve fuel and timber crisis in rural areas. By linking agro-forestry in integrated farming systems, the degradation of village forest area could be minimized to certain extent by supplementation of fuel and timber wood. By way of preserving the natural eco-system in the catchment areas, previously built up soil can also be preserved from erosion danger.

Integrated farming system helps the farmers in adoption of new technology, because of the linkage of dairy/mushroom/sericulture/fruit crops/vegetable crops, flower cultivation etc. As per the report by Chinnaswami, K.N., (1994), integrated farming system is said to be a feasible option in small and medium size farms, offering scope for higher income and higher productivity from different enterprises. Compared to conventional farming system**,** integrated farming system is more remunerative. According to Rangaswamy, A., P. Venkitasamy, M. Premseker, and S.P. Palaniappan (1992) integrated farming system could provide the solution for improving the economic status of Indian farmers.

According to Iqabalunddi (1987), integrated farming system provides a flow of money to the farmer round the year by way of disposal of eggs, milk,

edible mushroom, honey, cocoons of silkworm etc. This can help the resource poor farmer to get away from the clutches of usurious money lenders and from other financing agencies. In general, one can generate additional employment through integrated farming system.

The need for integrated farming has been realized. Diversification of agricultural activities which links farm based enterprises with rice cultivation would help the farmer to get more income and result in generation of additional employment. The population living in rural areas is under-nourished and it needs not only a large supplement of animal protein in its diet, but also new sources of gainful employment for sustained income. Fish culture could contribute towards solving these problems, such fish culture is possible in low land rice as rice is grown with a standing water column throughout the crops duration. WU-YW D.T. Cai and R.H. Shi (1991) noted that poultry farming is also another enterprise that could possibly be followed in integrated farming system, and it can go a long way in augmenting the income of small farmers, marginal farmers and other economically weaker sections. It requires a modest investment and no specialized or complex knowledge but the return is quick.

Rabbit farming is yet another enterprise that could be practiced inintegrated farming system, using fresh crop wastes as rabbit feed with amodest investment and no specialized or complex knowledge, thereby increasing the farm income . The most serious constraint in aquaculture technology is the high cost of inputs, especially fish feed and pond fertilization.This cost can be reduced considerably and the fish production could be increased by combining fish culture with poultry and rabbit farming. Thevoiding of poultry and rabbit could be recycled as fish feed and this could also increase the biological productivity of waste.

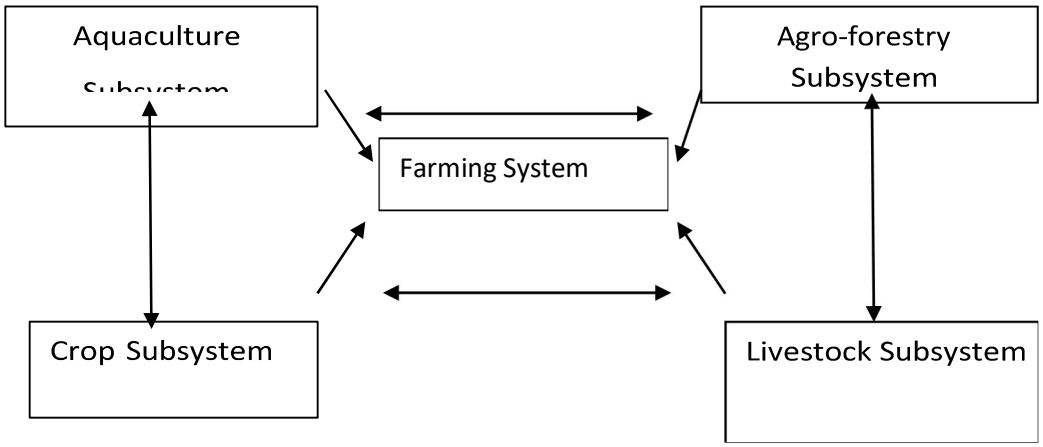
The aim of sustainable farming system should be to produce enough to meet the demand and needs of the society, be profitable to the practitioner, ~~and~~ conserve natural resource base and provide healthy and safe environment in the long run. The inter-related, inter-dependent, and inter-linking nature of integrated farming system, involves the utilization of primary produce and secondary produce of one system as basic input of the other system, thus making them mutually integrated as one whole unit. This incidentally helps to reduce the dependence on procurement of inputs from open market, making thereby the integrated farming system a self-supporting entity and sustainable system overtime.

Integration of Subsystem in Farming System

The various enterprises that could be included in the farming system are

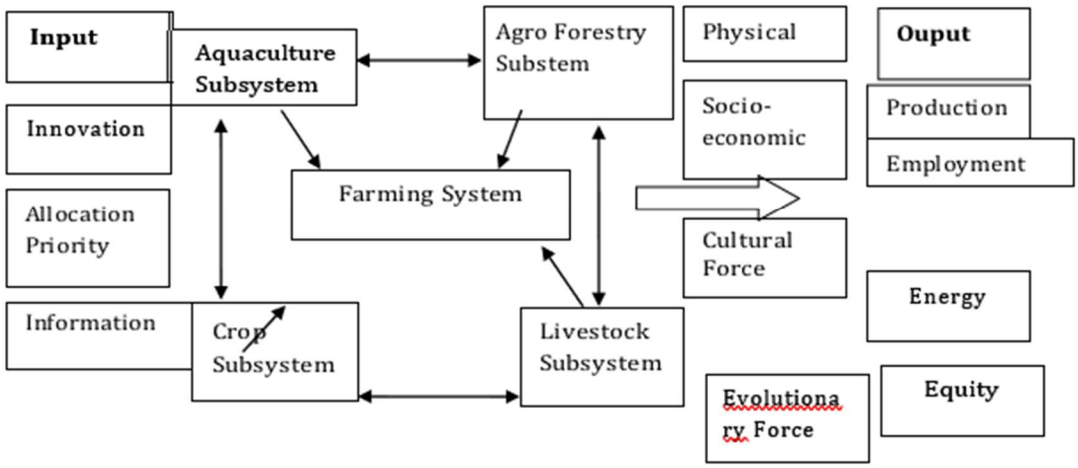
crops dairy, poultry, goat rearing, fishery, sericulture, agro-forestry, horticulture mushroom cultivation etc. It deals with utilization of wastes andresidues. It may be possible to reach the same level of yield with proportionately less input in the integrated farming and the yield would be interestingly more sustainable, because the waste of one enterprise becomes the input of another, leaving almost no waste to pollute the environment or to degrade the resource base. The knowledge of linkages and complementarities will help to develop integrated farming system in which the waste of one enterprise is more efficiently used as inputs in another within the system.

Fig. 1. Linkages of Different Enterprises in Farming System



Thus, farming system as a concept takes into account the components of soil, water, crops, livestock, labor and other resources with the farm family at the center managing agriculture and related activities. The farm family functions within the limitations of its capability and resources, the socio- cultural setting, and the interaction of these components with physical, biological and economic factors. In the conventional discipline or ommodity- oriented top-to-down research, the scientist is often not fully aware of theconstraints and limitations of the actual farm situation. Without the knowledge and proper understanding of the agro-climate and socio-economic milieu in which the farmers operate, many recommendations evolved at research stationare found inappropriate to the needs and environment of the practicing farmer.As a result, the research recommendations lose their relevance and are often not accepted by the potential beneficiaries, especially those with limited resources.

Fig-2 Integration of Subsystems into a Sustainable Farming System



Advantages of Integrated Farming System Productivity

Integrated Farming System provides opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises. Time concept by crop intensification and space concept by building up of vertical dimension through crops and allied enterprises are the ways to increase productivity.

Profitability

The system as a whole provides an opportunity to make use of the produce/waste material of one component as input on the other at the least cost. Thus, by reduction in cost of production of component two and by extending similarly on the other components linked, the profitability per rupee invested is being enhanced. Eliminating the interference of middleman in most of the inputs used and working out the net income for the farm as a whole will benefit the cost ratio.

Potentiality / Sustainability

Of late with an enthusiasm to produce more within the limited land area available to meet the requirement of additional population recorded at 2.2%, every year huge quantum of inorganic fertilizers, pesticides, fungicides, herbicides etc., are dumped. Thus, there is every possibility of soil and environment getting polluted. Once when we lose larger area by virtue of the

problem indicated, the fertility of the soil would automatically be eroded (~~reduced~~) in the years to come. In the integrated farming system, the organic supplementation through effective utilization of by-products of linked components as manures is possible and thus it can certainly provide an opportunity to sustain the potentiality of the production base viz., soil for much longer periods.

Balanced Food

In the integrated farming system, components of varied nature are linked enabling to produce different sources of nutrition viz., protein, carbohydrate, fat, minerals, and vitamins etc., from the same unit area. This can provide an opportunity to solve the malnutrition problem that exists in the diet of the Indian farmers.

Pollution Free Environment

In the process of production of crop based activity, some of the organics are left as waste material and such materials, when ignored, will pollute the environment on decomposition. Similarly, application of huge quantity of fertilizer, pesticide, fungicide and herbicide pollute the soil, water and environment to an alarming level. In the case of integrated farming system, linking appropriate components and thus utilizing the by-products as organic manures effectively utilize waste materials. Similarly, ~~by~~ adopting bio-control measures can help in preventing pollution of soil, water and atmosphere.

Recycling

Integrated farming system establishes its stability due to effective recycling of produces/waste materials of any one of the component as inputon the other linked in the programme. Thus, by way of recycling their ownmaterial at the farm level, the farmers would be able to reduce the cost of production which enables ultimately to increase the net income of the farm asa whole. Moreover, it also helps in reducing the environmental pollution expected out of decomposition of organic residues of the farm activity.

Money Round the Year

In conventional cultivation the money is expected only at the time of disposal of the produce which is received after five to fifteen months depending upon the duration of the crop,. In the integrated farming system the flow of money to the farmer is round the year by way of disposal of eggs, milk, edible

mushroom, honey, cocoons of silkworm, etc. This will help the poor farmers to get away from the clutches of usurious money lenders and from other financing agencies.

Adoption of New Technology

Most of the big farmers are fully aware of the impact of new technologies included in the package. But, for want of money, more than 80 per cent of the farmers who have been grouped under small and marginal categories are not able to execute the advanced technology . But in the integrated farming system because of the linkage of Dairy/Mushroom/Sericulture/ Fruit crops/Vegetables crops/Flower cultivation etc., money revolves round the year by sale of produce from these components at weekly/fortnightly intervals. Availability of cash round the year gives a sort of inducement to the small and marginal farmers to go for the adoption of organic technologies

Solve Energy Crisis

It is expected that the entire world is going to suffer for want of fossil fuel from 2030 AD. So it becomes inevitable to identify an alternative source to solve our energy crisis within a span of 3 to 4 decades. In the integratedfarming system, by way of effective recycling techniques, the organic wastes available in the system can be utilized to generate biogas. Though this may not be a source for complete supplementation, at least to certain extent the energy crisis anticipated can be solved.

Solve Fodder Crisis

In integrated farming system, each and every cm^2 of land area is effectively utilized. Growing of perennial fodder legume trees in the borders and water courses is a recommended practice in integrated farming system. This practice not only helps in supplementing legume fodder but also enriches soil nutrient by fixing the atmospheric nitrogen. In the cropped land also integrated farming system envisages intensification of cropping by including legume fodder like cowpea either as second tier or as third tier in the system. These practices will certainly relieve the crisis of non-availability of quality fodder to the animal component linked.

Solve Fuel and Timber Crisis

The national demand of fuel wood in 2020 AD is 400 million m^3, whereas the current production is only 20 million m^3. Similarly the requirement of industrial

wood in 2020 AD is 64.4 million m^3 and the current production levelis just 11 million m^3. The present level of production should be increased to twenty folds in the case of fuel wood and six folds in industrial wood. This could be possible to certain extent by a forestation programme in the shrub jungles and sparse forest areas. In integrated farming system by linking agro- forestry appropriately, can enhance the production level of fuel wood and industrial wood without detrimental effect on crop activity in the field level.

Avoid Degradation of Forests

There is a vast gap between the demand and production level as far as fuel wood and timber are concerned. This will naturally induce the users to encroach on the forest area nearby illegally to bridge the gap. Right now our forest area is less (22%) than the prescribed norms (33%) to the geographical area available. When such encroachments are encouraged, there is every possibility of our forest area going to be a wasteland in the years to come.Even in the forest area available at present more than $2/3^{rd}$ is sparse forest.The statistics on soil erosion indicates that every year 5374 million metric tons of built up soil is eroded in our country, which is four folds higher than the prescribed norms viz., 4 mt ha^{-1} $year^{-1}$. By linking agro-forestry in integrated farming system, the degradation of forest area could be minimized to certain extent by supplementation of fuel and timber wood. By way of preserving the natural eco-system in the catchment areas, precious built up soil can also be preserved from erosion danger.

Employment Generation

Combining crop enterprises with that of livestock to take advantage of complementary and supplementary relationship between them, would increasethe labour requirements tremendously and can help in solving the problem of underemployment to a great extent. Integrated farming system provides enough scope to employ family labour round the year.

Improves Literacy

The farmers, who adopt integrated farming system by combining different components like fishery, sericulture, mushroom cultivation, apiary, spawn production, dairy, poultry, agro horticulture, agro-forestry, biogas production, etc, get expertise in each and every aspects of individual component on long range adoption. This will help the farmers to face any challenge in their activity.

Integrated Intensive Farming System Models for Various Agro-Climatic Zones of Tamil nadu

Farming with crop cultivation alone will encounter certain specific problems like unstable income, under employment of farm family members and improper utilization of resources available in the farm. Integrated farming with allied activities like dairying, poultry, fishery, sheep and goat rearing piggery, rabbit rearing, duck farming, pigeon rearing, sericulture, apiary, mushroom production, biogas production, homestead garden, fruit tree cultivation and agro-forestry would result in stability of farm income with proper distributionof employment. Scientifically developed farming system models are available for stabilizing the farm income and standardizing the living of small andmarginal farmers.

Western Zone – Wet Land

Integration of cropping in 0.90 ha with fishery in 0.10 ha, 50 layers of poultry and 2 kg Oyster mushroom production per day with one hectare low land farming will result in higher net return of Rs. 35000/ha/year. (Or) Integration of cropping rice-gingelly-maize and rice-soyabean-sunflower in 0.90ha with 0.10 ha poly-culture fish rearing, 100 pairs of pigeon and 2 kgmushroom production per day could result in higher net return of Rs. 88700 inone hectare farming with additional employment of 300 mandays/year.

Garden Land

Integration of six cross breed milch animal with $2m^3$ biogas production, mushroom production (2kg), and 20 bottles of mushroom spawn with farm forestry and homestead garden results in higher net return Rs. 34,580 with 1250 mandays employment in one hectare farming under garden landcondition.

Rainfed Land

Integration of grain crop cultivation with fodder production and sylvi-pastroal system involving trees like soobabul, Acacia sp., A and thorn less prosophis interplanted with cenchrus grasses and rearing of 20 female and one Telicherry goat results in additional income of Rs 5970/ha in rain fed farming.

II North Western Zone

Crop cultivation in rain fed lands can be integrated with 3 milch cows, 6 layers of poultry in 0.80 ha land area will fetch additional income.

(or) Integration of cropping with 2 milch animal, 6 goats in 1.25 ha rain fed land, out of which 0.25 ha with mulberry cultivation of sericulture results inthe net return of Rs. 28560 / year.

III Hilly Zone

To obtain higher income and regular employment in hilly zone, crop cultivation can be integrated with 2 milch cows, 6 poultry layers and 9 boilers.

IV Cauvery Delta Zone

Integration of rice based cropping with 2 milch animal resulted in Rs.19900 net income or 6 goat rearing with crop cultivation fetched Rs. 35400 or cropping with duck and fish rearing resulted in a net return of Rs. 24110 and when this system is integrated with mushroom cultivation there is 25% additional income in lowland condition.

V Southern Zone

Integration of rice based cropping with fish rearing and poultry in one hectare land area fetched an additional income of Rs. 9530 under Periyar Vaigai command area. Integration of milch cow and fish rearing with rice based cropping system in wetlands of Tirunelveli district will fetch revenue of Rs. 25210 as net income. In rain fed black day clay soil integration of cropping with fruit tree cultivation and goat rearing will result in better returns.

Conclusion

The sustainable agriculture depends on practicing integrated farming system. This type of farming system enables one to enhance the farm activities throughout the year consequent upon cultivation of different crops along with practicing allied activities of agriculture. One can find continues, steady, stable, permanent and everlasting farming activities throughout the year only through integrated farming system and such type of farming system is called sustainable farming system. Thus the sustainable agriculture could be achieved through integrated farming system.

References

Govindan, R., K. N. Chinnaswami, B. Chandrasekaran, M. N. Budhar and J. Price, Poultry-Fish Culture in Rice Farming System in Cauvery Delta Region of Tamilnadu, Indian J. Agron, 1990, Vol. 35, No. 192, pp. 23-29.

Swift, M., and Wommer, P.F. Organic Matter: The Sustainability of Agriculture

Systems: Nutrition and Measurements in Merely and K. Mulonosy (ed.,) Dynamics of Organic Matter in Relation to Sustainability of Agricultural System, John Wiley and Sons, Chichester, 1993.
Velu, R., Behavioural Respnse of Earthworms Lampire Maurti to Fertilizer Salts," Paper Presented at National Seminar on Animal Behaviour and XVI Annual Conference of Ecological Society of India, Bangalore, 1987, pp. 30-31.
D. Pearlberg, Farm and Food Policy: Issues of the 1980s, Lincon University of Nebraska Press, 1980.
D. Pimental, Low Input Sustainable Agriculture, Using Ecological Management Practices, Agriculture, Ecosystems and Environment, Vol. 27, No. 3, 1989, p.24.
Lal, R. Effects of Macro Fauna on Soil Properties in Tropical Ecosystem, Agriculture, Ecosystem and Environment, Vol. 243, No. 3, 1988, pp. 101-116.
Zhang, J.H., S.W. Tan, X.Y. Liu, and F. Hong, Oxidation Stability of Organic Matter and Fractionation of Organic Phosphorus in Soils with Different Fertility, Journal of Soil Science, Vol. 19, No. 2, 1988, pp. 60-62.
Sharma, B.K., M.K. Das, and D.P. Chakkraborthy, Integrated Fish cum Poultry Farming, Agriculture, Extension Manual News Series 5, 1985, pp. 20-29.
Robert, C., Oehalf Organic Agriculture, Wiley and Sons, 1978, p. 271.
Dhaliwal, G.S., and B. Singh, eds: Pesticides: The Ecological Impact on Developing Countries, Common Wealth Publishers, New Delhi, 1993, p. 517.
Lv. S.S. and C.P. Huang, Economic and Ecological Effects of Fish Culture in Paddy Fields, Journal of Ecology, China, Vol. 17, No. 4, 1988, pp. 26-29.
Vincke, P., and J.C. Micha Fish Culture in Rice Fields International Rice Common News FAO/IRC, Vol. 34, 1985, pp. 297-314.
Mohammed Ali, R. Siddeswaran, S. Jaganathan, S. Muthusamy ands. Subramanian, Efficiency of Mixed Farming in the Tribal Areas of Sheveroy Hills, Madras Agricultural Journal, Vol. 71, 1984, pp. 294-298.
Ayyanan, M., A. Chellakumar, V. Tamilmani and C. Udayasoorian, Recycling of Poultry Waste in Integrated Fish Farming, Madras Agricultural Journal, Vol.78, No. 5-8, 1991, pp. 2000-2003.
Ravikumar, R.V. and K.K. Krishnamoorthy, Efficient Utilization of Industrial and Farm Wastes as Soil Amendments IN. Proc National Seminar on Utilization of Organic Wastes, Agricultural College and Research Institute, Tamilnadu Agricultural University, Madurai 24-25, March 1983, p. 147-150.
WU-YW D.T. Cai and R.H. Shi, Partitioning of Nitrogen From Rabbit Excreta and Ammonium Sulphate and Soil Nitrogen in the Rice Crop – Acta Pedagogical Sinica, Vol. 28, No. 2, 1991, pp. 161-167.

Aruna Rajagopal, Integrated Farming and Social Status in Proceeding of Summer Institute on Integrated Farming System Research and Management for Sustainable Agriculture, Tamilnadu, Agriculture University, Coimbatore, 1994, pp. 245-251.

Chinnaswami, K.N., Farming System Research and Development in Cauvery Delta and North Western Zone in Tamilnadu. In Proceedings of Summer Institute on Integrated Farming System Research and Development for Sustainable Agriculture, Coimbatore, 6-15 June 1994, pp. 252-257..