A Review on the Integrated Rice-Based Cropping Systems Practices in the Philippines

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Abstract

In agriculture, crop production is the main activity. The income obtained from crops may hardly be sufficient to sustain the farm family throughout the year most especially due to the varying climatic conditions, pest infestations and disease infections. Thus, assured regular cash flow is possible when the crop is combined with other enterprises or integrating other crops. However, judicious combination of enterprises is also an important consideration and keeping in view of the environmental conditions in a locality to achieve greater dividends among the produce crops. At the same time, it will also promote effective recycling of residues/wastes. Some of the rice-based cropping system applied in the country includes rice + vegetable production system, rice + off-season vegetable production system, rice + fish production system, rice + duck integration system, rice-rice cropping pattern, rice-upland crops cropping pattern, irrigated lowland farming systems and sustainable agroforest land technology. Moreover, Integrated Farming Systems provided a steady and stable income to the farmers. Thus, amelioration of the system's productivity and achieve agro-ecological equilibrium through the reduction in the build-up of pests and diseases, through natural cropping system management. Likewise, multiple cropping systems productivity is higher in terms of harvestable products per unit area per unit time than those of sole cropping systems. Thus, this practice provided higher net income by the Filipino farmers.

Keywords: Integrated farming systems, rice based cropping, yield and income

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INTRODUCTION

All over the world, farmers work hard but do not make money, especially small farmers because there is very little left after they pay for all inputs (seeds, livestock breeds, fertilizers, pesticides, energy, feed, and labor). However, (Kumara et al. 2017) stated that the emergence of Integrated Farming Systems (IFS) enabled the development of a framework for an alternative development model to improve the feasibility of small sized farming operations in relation to larger ones. Integrated farming system (or integrated agriculture) is commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches.

It refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as Integrated Biosystems.

This system is an interrelated set of enterprises used so that the “waste” from one component becomes an input for another part of the system, which reduces cost and improves productionSince it utilizes wastes as resources, it does not only eliminate waste, but ensures overall increase in productivity for the whole agricultural systems. It also avoids the environmental impacts caused by wastes from intensive activitiessuch as pig farming (CARDI, 2010).

One of this integrated farming system include rice based cropping system. Rice based cropping system is described as a mix of farming practices that comprises of rice as the major crop, followed by the subsequent cultivation of other crops. Inter-cropping of rice andother compatible crops is also widely practiced in this system. The concepts associated with integrated farming system (IFS) are practiced by numerous farmers throughout the globe. A common characteristic of these systems is that they have a combination of crop and livestock enterprises and in some cases may include combinations of aquaculture and trees. It is a component of farming systems which takes into account the concepts of minimizing risk, increasing total production and profits by lowering external inputs through recycling and improving the utilization of organic wastes and crop residues (CARDI, 2010).

Today numerous Integrated Farming and Waste Management Systems or Integrated Farming System models have been developed and applied. These systems combine livestock, aquaculture, agriculture and agro-industry in an expanded symbiotic or synergistic system, so that the wastes of one process become the input for other processes, with or without treatment to provide the means of production such as energy, fertilizer, and feed for optimum productivity at minimum costs. Example of this includes: pig tractor" systems where the animals are confined in crop fields well prior to planting and "plow" the field by digging for roots, poultry used in orchards or vineyards after harvest to clear rotten fruit and weeds while fertilizing the soil. While, the cattle or other livestock allowed to graze cover crop between crops on farms that contain both cropland and pasture, water-based agricultural systems that provide way for effective and efficient recycling of farm nutrients producing fuel, fertilizer and a compost tea/mineralized irrigation water in the process. In this respect integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming systems. The difference between mixed farming and integrated farming is that enterprises in the integratedfarming systems interact eco-biologically in space and time, are mutually supportive and depend on each other (CARDI, 2010).

Advantages of Integrated Farming System include pooling and sharing of resources/inputs, efficient use of family labor, conservation, preservation and utilization of farm biomass including non-conventional feed and fodder resources, effective use manure/animal waste, regulation of soil fertility and health, income and employment generation for many people and increase economic resources. Thus, Integrated Farming System is part of the strategy in ensuring sustainable use of the natural resources for the benefit of present and future generations (Munandar et al., 2015).

Hence, this paper was conceptualized to assess the technology of integrated farming systems practices in the Philippines particularly in rice-basedcropping system, to evaluate the significance of different rice-based farming systems practiced in the Philippine agriculture, to assess the productivity of the different farming systems practiced by the farmers in the Philippines.

Goals of Integrated Farming Systems

The Goals of this Integrated Farming Systems (IFS) are to: provide a steady and stable income rejuvenation/amelioration of the system's productivity and achieve agro-ecological equilibrium through the reduction in the build-up of pests and diseases, through natural cropping system management and the reduction in the use of chemicals (in-organic fertilizers and pesticides).

Advantages of Integrated Farming Systems

It improves space utilization and increase productivity per unit area. It provides diversified products, improves soil fertility and soil physical structure from appropriate crop rotation andusing cover crop and organic compost, reduce weeds, insect pests and diseases from appropriate crop rotation, Utilization of crop residues and livestock wastes, Less reliance to outside inputs – fertilizers, agrochemicals, feeds, energy, etc. Higher net returns to land and labor resources of the farming family

Scope of Farming System

Farming enterprises include crop, livestock, poultry, fish, tree crops, plantation crops, etc. A combination of one or more enterprises with cropping, when carefully chosen, planned and executed, gives greater dividends than a single enterprise, especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity. Integration of farm enterprisesto be combined on many factors such as soil and climatic features of the selected area, availability of resources, land, labor and capital, present level of utilization of resources. Economics of proposed integrated farming system and managerial skill of the farmer.

Components of Integrated Farming Systems

The components of Integrated Farming Systems (IFS) include crops, fish farming, poultry, pigs, cattle, sheep and goat, fodder production and kitchen gardening. The feeds derived from "alternative" crops (sugarcane, roots and leaves of cassava, leaves of nacedero, mulberry, chaya, grasses) require"alternative" farming systems. Such examples are on small-scale which are highly productive.

RESULTS AND DISCUSSION

Rice-Based Cropping System Practiced in the Philippines

Philippines is predominantly an agricultural country which is generally small-scale and dependent on manual labor. It is also characterized by varying topographies and soil types; diverse flora and fauna and a mélange of cultures in numerous communities (Zamora and de Guzman, 2012). Thirty-two percent of the total land area of the country is agricultural lands, 51 and 44% of which is arable and permanent croplands, respectively (Philippine Statistics Authority, 2014). Although, there are some commercial and semi- commercial farms, but the majority are landless farm workers and small subsistence farms with a mean area of 2.0 ha per farm. Considering the importance of the agricultural sector to the Philippine economy, it isironic that today, 66% of the poor are in agriculture, forestry and fisheries sector. Poverty incidence in the rural areas is 68% compared to only 34% in the urban areas. The poorest ofthe poor are the indigenous peoples, small-scale farmers who cultivate land received through agrarian reform, landless workers, fishers, people in upland areas and women. The highest poverty incidence is found among corn farmers (41%), rice and corn workers (36%), sugarcane farm workers, coconut farm workers, forestry workers (33%), and fishers (31%) in the coastal waters (Zamora, 2010). A viable agricultural solution to this problem is the practice of diversified and integrated farming systems (Garrett et al 2017).

The idea of biodiversity-based farming systems is not new. For centuries, farming communities have painstakingly developed resilient and bountiful agricultural systems based on biodiversity, and on their knowledge of how to work with them in equally complex biophysical and socio-cultural settings. Farmers have used diversity for food and economic security through a complex array of home garden designs, agroforestry systems and diversified and integrated lowland farming systems. It differs substantially from conventional modern agriculture in that its focus is the establishment of functional diversity in the farm, rather than monoculture. These systems are time-tested and locally adapted (Zamora, 2010). Some of the rice-based cropping system applied in the country includes rice + vegetable production system, rice + off-season vegetable production system, rice + fish production system, rice + duck integration system, rice-rice cropping pattern, rice-upland crops cropping pattern, irrigated lowland farming systems and sustainable agroforest land technology.

Palayamanan Plus

Palayamanan is a term coined from the words palayan (ricefield) and kayamanan (wealth), which refers to a field where more wealth is created based on rice as well as some other crops. In the model established at PhilRice Maligaya, the concept is translated in terms of diversified rice-based farm operations. The Palayamanan diversified farming system has been designed as an alternative system of production that may solve some of the major concerns related to intensive rice production. According to (Thorat et al., 2015), intensive rice production leads to long-term biophysical changes that threaten the ecological sustainability of farming as reflected in the loss of diversity, declining productivity, falling profitability, input inefficiencies, and environmental and health risks. All these factors have serious implications for economic sustainability (Kabir, 1999).

Productivity of most multiple cropping systems is higher in termsof harvestable products per unit area given with the same levels of management as those of sole crops. Total biomass is also higher and helps to increase sustainability of the farm, Paciello, (2015). To optimize the viability of farming, it is important to choose and mix crops. The production of rice and some cash crops are very definite as dictated by the growing conditions. In the case of vegetables, the ideal times mostly preferred. Silici, et al. (2015) mentioned that as several crops are grown, failure of onecrop to produce enough or earn enough can be compensated for by other crops. It may be necessary to alter the combinations of crops to make more efficient use of resources such as nutrients, water, and labor to restore soil fertility, or to decrease populations of pests. Some suggested techniques are staggered planting, sequential cropping, relay cropping, rotation and succession (Singh et al., 2007). According to a study conducted by Corales et al., (2005) whom documented the economic analysis of different components of palayamanan, they concluded that palayamanan model farm shows how enterprises can be integrated in the same farm so that the overall operations becomes profitable and sustainable.

Based on the data they've presented, although the animal component of the model farm has not been fully completed, it has already generated a net income of more than P11, 000 for the two cycles in one year (Table 1).

Table 1. Analysis of the animal components for one-year cycle, 2002

Animals	Gross Income (P)	Expenses (P)	Net Income (P)
Feb-June 2002			
Pigs (5 head)	19,500	11,522	7, 978
Chicken (20 head)	6,300	3,840	2,460
Sub-total	**25,800**	**15,362**	**10,438**
August-Dec. 2002			
Pigs (5 head)	15,600	16,680	(1, 080)
Chicken (20 head)	7,170	4,862	2,308
Sub-total	**22,770**	**21,542**	**1,228**
Grand Total	**48,570**	**36,904**	**11,666**

A net income of more than P10, 000 obtained during the first cycle was attributed tothe reduction in feed expenses. The vegetable surplus supplemented almost 50% of the feed consumption. The loss incurred in the surplus production of the vegetables was absorbed bythe animal component. According to Anyaehie and Areji, (2015), animal keeping extends the risk reduction strategy beyond crop production, and thus increases the potential for economic stability of the farm. During the second animal cycle (August- December), a negative income from the pig production was attributed to high feed consumption and drop in the market price. The animals were generated a certain income was still realized from the animal component. As added benefits, animals transform biomass into quality organic nutrients more quickly than the natural system. Organic fertilizers harvested from the mixture of mulch beddings. Furthermore, economic analysis of the different crop production components is also shown in Table 2.

Based on their presented data, rice as a major component of the system can still generate a lucrative income despite controlled pricing by certain sectors. Several strategies can be mostly fed with commercial feeds during the growing period because of limited feed supplement coming from the crop production component. The loss incurred in the pig production was compensated by the income derived from the chicken production; employed such as planting special rice varieties, or employing production management which command higher prices like an organic-based production system. The production of special rice varieties and an organic-based system is feasible under the diversified farming system because of the limited area. In the model farm, we planted PJ lines and the Mestizo hybrid rice, special rice varieties, coupled with an organic-based system. Normally, the command price is more than P1 premium price per kilo over the ordinary rice. Much higherbenefit can be obtained when the rice is sold as milled rice, animal manure and urine is about100 bags per cycle or 200 bags per year.

Table 2. Analysis of the crop component, 2002 (area for each component=25 ha)

Component	Yield (kg)	Gross (P)	Expenses (P)	Income (P)
Rice-Onion				
Rice	1,500	18,000	2,955	15,045
Onion	2,400	24,000	6,800	17,200
Sub-total		42,000	9,755	32,245
Rice-Fish (2 cycle)				
Rice	2750	26,250	5,500	20,750
Fish	233	8,155	3,800	4,355
Gabi	1,000 pc	3,000	900	2,100
Sub-total		37,405	10,200	27,205
Cash crops				
Corn (green)	900	9,000	3,750	5,250
Vegetables		21,210	6,363	14,847
Sub-total		30,210	10,113	20,097
Grand Total		109,615	30,068	79,547

Another crop, onion is one of the most attractive crops after rice because of its high yield and high net income. However, it is becoming unpredictable due to the volatility of theprice. Thus, green corn is a more probable crop planted after rice. It can also provide a goodincome with lesser inputs. Vegetables also provide good income especially during their off-season. Vegetablesplanted during the dry season obtain higher yields but again they are subject to price fluctuations. In our experience, tomato is one of the volatile crops during the dry season because of very extreme low prices when the supply becomes too much for the market to absorb. Gabi production is also an added dimension of the overall farming system because it can be planted around the rice paddies and irrigation canals. It interferes the least with rice, needs minimal management, and is self-sustaining. Taro can be sold P3-5/plant farm gate price. The suckers are sold at P0.25-0.50 per piece. One of the farmers with diversified farm mentioned that the income generated from gabi was higher than that from the rice. In general, the crop production components can obtain considerable income much higher than in rice production alone despite some of the failures such as damaged crops, lessproduction due to weather and pest, and low prices inflicted to some of the crops especially vegetables.

This shows that the diversification of crops can buffer losses incurred in some individual crops. Moreover, the synergism of crop production to animal production plays animportant role in the revaluation of some product outputs such as discards. Normally these are wasted; they can be converted into nutrients for the benefit of succeeding crops. Value added can be produced by converting discards into animal feed supplements before they arebrought back into the farm in the form of manure or organic fertilizer (Corales et al., 2004).

Rice-Rice Cropping Pattern

The rice-rice cropping pattern reduce the period for land preparation and transplanting usually spent under traditional rice culture. The soil is prepared dry and plantingis done even before the first rain to give time for the second crop. The land preparation for the second crop be done as quickly as possible so that planting completed early to avoid waterstress from the oncoming dry season. The sequence of activities in rice-rice pattern is characterized by precise timing and pronounced peaks in the labor requirements occurring between the first crops and planting of the second crop. The time of planting is determined by the need to avoid time wastage rather than to suit the climatic condition. Consequently, the probability of water stress at seedling stage of the first crop and grain filling stage of the second crop is increased. Also, the harvesting period of the first cropusually coincides with peak rainy period making grain drying a problem.

Rice-Upland Crops Cropping Pattern

With a short life cycle of rice (less than four months), planting of other upland crops such as mungbean is used to maintain crop production all year long. A careful selection of fast maturing crops at different times of the year is made to cope with the cyclical fluctuationsof climate and economic environment of the farm. Usually, in a rice-upland crops cropping pattern the growing of upland crops is doneto make use of residual moisture present at this period usually towards the dry months. Important characteristics of upland crop planted after rainfed rice is that it must have short maturing and resistant to drought.

Sustainable Agroforest Land Technology (SALT)

SALT (Sustainable Agroforest Land Technology) is based on small-scale reforestation integrated with food production. Of the farm area, about 40% is used forcrops and 60% for forestry. This“food-wood” intercropping can effectively conserve the soil, thereby providing food, wood and income tothe sloping land farmers. It has been designed for a 2 hectares upland farm and aims to produce food, fruit, animal feed, fertilizer, fuelwood and timber. The farmer plants woody perennials to form hedgerows along the contour lines which are spaced 4-6m apart. Every first and second alley between the hedgerows is planted with annual crops which include corn, upland rice, beans, ginger, and pineapple. Crop rotation in these alleys helps maintain soil fertility and good soil formation. In every third alley, farmers plant fruit trees and other permanent cash crops such as coffee, cacao (*Theobroma cacao*), banana, calamansi (*Citrofortunella microcarpa*), guava, rambutan (*Nephelium lappaceum*), durian (*Durio zibethinus*), mango, jackfruit, and lanzones. During the initial development phase, shorttermcash crops such as cowpea (*Vigna unguiculata*), peanut, mungbean (*Vigna radiata*), eggplant, and tomato may also be planted. Hedgerows are cut when they grow to a height of 2 m.

Cut foliage is spread in the alleys to provide organic fertilizer. The 1-ha portion of the farm upslope from the agroforestry plot is used for tree production. Farmers are encouragedto plant a variety of species which are short, medium and long-term (Singh et al.).

Table 3. Annual net income of farmers before and after adopting SALT, on a 0.75 ha farms (Laquihon, 1897 cited by Watson, undated)

SALT Farmers	**Mean net income before SALT**	**Mean net income afterSALT**	**Net increase after SALT**	**% increase after SALT**
Farmers in Luzon*	1.83	3.53	1.70	3.72
Farmers in Visayas**	1.91	3.72	1.81	3.76
Farmers in Mindanao***	1.99	3.63	1.64	3.28
Mean 1.91	3.63	1.72	3.61	
***N = 34; **N = 21; *** N = 61**				

Sorjan Farming System

Last 2016, La Niña was forecasted to hit the country. To cope up the upcoming phenomenon experts from the Philippine Rice Research Institute (PhilRice) have evaluated the Sorjan cropping system in response to climate change, to maximize farm productivity and ensure food security and regular income of farming families. Sorjan, developed by Indonesian farmers, is a system that constructs an alternate of deep sinks and raised beds. Its features can adapt to both dry and wet seasons. The low bedscan be planted to lowland rice and can be used for fish and culture while the raised beds canbe used for upland crops as upland rice, corn, grain legumes and vegetables. This cropping system is advantageous as it allows diversification of crops, spreadrisks and when properly managed could provide a continuous food supply for the family.

Advantages of Rice-Based Cropping System

Rice (*Oryza sativa*) is a component of widely varying cropping systems. Rice – based cropping systems form an integral part of agriculture (Porpavai, et al. 2016). Several intensive rice based cropping systems have been identified and are being practiced by the farmers. While intensive agriculture, involving exhaustive high yielding varieties of rice andother crops, has led to heavy withdrawal of nutrients from the soil, imbalanced and discriminate use of chemical fertilizers has resulted in deterioration of soil health (Reddy and Sang-Arun, 2011). Thus, suitable rice based cropping has to be evaluated, to assess the stability inproduction.

Effects of Rice – Based Cropping System on the Available N of the Soil

In relation to post harvest soil available N, it was noted that the initial available nitrogen status of the soil was 217 kg/ha. Progressive increase in available N status after eachyear was observed with the inclusion of leguminous crop in the rotation.

Among the croppingsystems tested rice – rice – black gram, onion – rice – black gram, groundnut – rice – black gram and rice – rice – green gram cropping systems significantly improved the soil availablenitrogen status in the first, second, third and fourth year respectively.

The fixation of atmospheric nitrogen by the leguminous crops might have contributed for the increased soilN status (Mohanty et al., 2010b). When compared to first year, the soil available N status was improved in groundnut – rice – blackgram (14 kg/ha), rice – rice – greengram (12 kg/ha), rice – rice – blackgram (9 kg/ha) onion – rice – blackgram (8 kg/ha) atthe end of the fourth year. Though the quantity of available nitrogen contributed was not huge, positive trend was observed with the maintenance of soil available nitrogen status. The soil available N status was depleted in maize – rice – sesame (20 kg/ha) and rice – rice – sesame (19 kg/ha) due to the exhaustive nature of maize and sesame. This was followed by bhendi-rice-radish (13 kg/ha), rice-rice-onion (8 kg/ha) cropping systems. Rice – rice – blackgram, onion – rice – blackgram, groundnut – rice – blackgram and rice – rice – greengram cropping systems improved the post-harvest soil available N status. Increase in available nitrogen, phosphorus,potassium and sulfur content in cropping sequences involving vegetable, pea, green gram was reported by Kumar and Jain, (2005). Cultivation of legume crop is viewed more as asoil fertility improver than as independent crops grown for their grain output. This is becauselegume crops are self-sufficient in N supply (Devendra, 2011).

Effects of Rice – Based Cropping System on the Yield Performance

The preceding crop species can have a beneficial or detrimental effect on the performance of the succeeding crop. The well-known beneficial effects of preceding legume crop on cereal are also found in multiple cropping systems, but the magnitude of the effects varies with management practices and the legume species used. Progressive increase in the grain yield of kharif crops preceded by pulses was recorded in rice-rice- blackgram and rice-rice- green gram cropping systems in the second, third and fourth year. When compared to the first year, the yield increase of 430 to 446 kg was recorded in the fourth year**.** According to **(**Ehsanul, 2016) he reported similar result, pointing out the superiority of leguminous cropsin increasing the yield of the succeeding crops of rice. They also observed a reduction in theyield of rice grown after sesame. The grain yield of kharif season crops decreased in rice- rice-sesame, rice-rice-bhendi, lab-lab-rice- maize, bhendi-rice-radish, maize-rice sesame cropping systems. The grain yield of kharif season crops are maintained without any reduction in onion-rice-black gram, rice-rice-onion and groundnut-rice black gram croppingsystems. Legumes were potentially important to diversify cereal based mono cropping into cereal-legume sequences which had nutrient cycling advantages. Moreover, another study conducted by Ali, et al. (2012) revealed that green manuringof sesbania rostrate and legume crops (mungbean, cowpeas and lentil) produced significantlybetter grain yield of rice and wheat than the other crops.

Maximum paddy yield of 3.73 t/ha was produced by rice – wheat – sesbanian cropping system followed by 3.57, 3.52, 3.40 and 3.39 t/ha produced by rice – wheat – mungbean, rice – cropping systems respectively and these were statistically at par with each other. The other cropping patterns gave significantly lower yields. Rice - wheat system produce paddy yield of 3.34 t/ha. Sowingof sesbania rostrate increased rice yield by 12%, mungbean (7.2 %), Berseem (5.3 %), cowpeas (1.8 %) over the traditional rice – wheat cropping system.

Almost similar yield trends were found in case of wheat crop. Rice – wheat – sesbania increased wheat yield (2.81 t/ha), rice – wheat – cowpeas (2.69 t/ha) and rice – wheat – mungbean (2.63 t/ha) while the prevailing rice – wheat system produced wheat grain yield of 2.59 t/ha. Rice- wheat – sesbania cropping system increased wheat yield by 7.8 %, cowpeas (3.9 %), mungbean (3.5 %) over traditional rice – wheat cropping system. The paddy yield was slightly decreased incase of sunflower and canola crops (3.32 & 3.21 t/ha respectively) than rice wheat system where the yield was 3.34 t/ha which may be that these crops are nutrients exhaustive. Channabasavanna et al. (2009) reported similar results that rice – wheat yield increased after legume pulses e.g. chickpea and lentil. The results are also in line with (Gill, et al. 2009) who reported the best one year crop rotation was rice – wheat – mungbean. It is evident from the resultsthat mungbean and cowpeas which are pulses as well as leguminous crops can be adjusted inthe rice - wheat cropping system for increasing income per unit area and improving soil health. It is short duration (65 - 70 days) crops and can be grown easily during the fallow period between wheat and rice crop.

CONCLUSION AND RECOMMENDATIONS

The paper presented several examples of Integrated Farming System practicedin the Philippines. These farming systems mostly focused on resource-poor farmers, not only to improve their livelihood and nutrition, but also to conserve our resources as well as to protect our fragile environment. In general, diversified farming systems can sustain most of a family's food requirements, incidental expenses and generate reasonable net income from the different crops and animals. The application of cost-saving and yield-enhancing practices enhance the efficiency of operations in the farm, making it more economically stable. Moreover, productivity of most multiple cropping systems practiced by the farmers in the Philippines is higher in termsof harvestable products per unit area per unit time, given with the same levels of management than those of sole cropping systems. Thus, this practice provided higher net income by the Filipino farmers.

It is recommended that a regular evaluationof the performance of each component is important to make necessary adjustments to fit thelocal conditions and stability of the system. This shows that the diversification of crops can buffer losses incurred in some individual crops. Normally, farm wastes are discarded when in fact they can be converted into nutrients for the benefit of succeeding crops.

REFERENCES

Ali R. I. et al., 2012. Diversification of rice-based cropping systems to improve soil fertility, sustainable productivity and economics." *Journal of Animal and plant sciences* 22.1, 108-12.

Anyaehie M.C. & Areji A.C. 2015. Economic Diversification for Sustainable Development in Nigeria," *Open Journal of Political Science,* 5, pp. 87-94.

Ehsanul H.M.D., 2016. Suitable Integrated Crop-livestock Production System in Char area of Bangladesh, *Journal Fisheries Livest Prod* 4: 156.

Caribbean Agricultural Research and Development Institute (CARDI). 2010. A Manual on Integrated Farming Systems (IFS). www.belize.org (Data retrieved: April 10, 2017).

Channabasavanna A. S., Biradar D. P., Prabhudev K. N. & Hegde M. 2009. Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. Karnataka Journal of Agricultural Science, 22(1), 25–27.

Corales R. G., Juliano L.M., Capistrano A.O.V. Tobias H.S., Dasalla N.V. Canete S.D., Casimero M.C. & Sebastian L.S. 2004. Palayamanan: Arice-Based Farming Systems Model for Small-Scale Farmers. *Philippine Journal of Crop Science* 29(1): 21-27.

Devendra C. 2011. Invited review – Integrated tree crops-ruminants systems in South East Asia: Advances in productivity enhancement and environmental sustainability. Asian-Australasian Journal of Animal Sciences, 24, 587–602.

Garrett R.D., Niles M., Gil J., Dy Philip, Reis J. & Valentim J. 2017. Policies for Reintegrating Crop and Livestock Systems: A Comparative Analysis," Sustainability, 9, 473, www.mdpi.com/ journal/sustainability, pp. 136-148.

Gill M. S., Singh J. P. & Gangwar K. S. 2009. Integrated farming system and agriculture sustainability. *Indian Journal of Agronomy*, 54(2), 128–139.

Kumar S. & Jain D. K. 2005. Are linkages between crops and livestock important for the sustainability of the farming system? *Asian Economic Review*, 47(1), 90–101.

Kumara O., Sannathimmappa H.G., Basavarajappa D.N., Danaraddi V.S., Pasha A. & Rajani S.R. 2017. Integrated Farming System - An Approach towards Livelihood Security, Resource Conservation and Sustainable Production for Small and Marginal Farmers, *International Journal of Plant and Soil Science,* 15(3), pp. 1-9.

Birthal P. S., Joshi P. K. & Narayanan A. V. 2011. Agricultural diversification in India: Trends, contribution to growth and small farmer participation. Patancheru: The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), mimeo.

Mohanty R. K., Thakur, A. K., Ghosh, S., & Patil, D. U. (2010b). Impact of rice fish prawn culture on rice field ecology and productivity. *Indian Journal of Agricultural Sciences*, 80, 597–602.

Munandar Gustiar F, Yakup, Hayati R. & Munawar A.I. 2015. Crop-Cattle Integrated Farming System: An Alternative of Climatic Change Mitigation, *Livestock Media Journal* 38(2), pp. 95-103.

Paciello M.C. 2015. Building Sustainable Agriculture for Food Security in the Euro-Mediterranean Area: Challenges and Policy Options," Edizioni Nuova Cultura, Roma.

Parreño-de Guzman, Lucille Elna, Oscar B. Zamora, & Dora Fe H. Bernardo. 2015. Diversified and Integrated Farming Systems (DIFS): Philippine Experiences for Improved Livelihood and Nutrition." *Journal of Developments in Sustainable Agriculture* 10.1: 19-33.

Porpavai, S., et al. 2011. Impact of various rice based cropping systems on soil fertility.*Journal of cereals and oilseeds* 2.3 (2011): 43-46.

Reddy V. & Sang-Arun J. 2011. Promoting coconut-based agro-ecosystem and efficient product utilisation for augmenting on-farm income, improving quality of environment and conserving natural resources. Occasional Paper, IGES. p. 25.

Silici L., Bias C. & Cavane E. 2015. Sustainable agriculture for small-scale farmers in Mozambique: A Scoping," Report. IIED Country Report, London.

Singh K., Bohra J. S., Singh T. K., Singh J. P., Singh Y., & Singh C. S. 2007. Productivity and economics of integrated farming system in irrigated agroecosystem of Uttar Pradesh. *Indian Journal of Agronomy,* 52, 7–10.

Thorat B. N., Thombre B. M. & Dadge A. V. 2015. Management of Dairy Cow and Buffalo in Integrated Farming Systems Model in Marathwada Region of Maharashtra," *International Journal of Tropical Agriculture,* Vol. 33, No. 2, pp. 653-657.

Zamora O.B. 2010. Fundamentals of Sustainable Agriculture: Resource Materials for Courses in Sustainable Agriculture. Crop Science Cluster, College of Agriculture, Universityof the Philippines Los Baños. 189 p.

Zamora O.B., de Guzman L.E.P. & Talubo J.P.P., 2014. Sustainable Upland Agricultural Practices of Some Indigenous Peoples in the Philippines. 25 p. In: Cairns, M. (Editor). A Growing Forest of Voices: Integrating Indigenous Knowledge in Sustainable Upland Farming. (in press).

http://www.philrice.gov.ph/philrice-adopts-sorjan-cropping system/#sthash.2ZWL8MGu.dpuf