Doubling Farmers’ Income through Integrated Farming System Approach in Purba Barddhaman District of West Bengal

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Authors’ contributions

This work was carried out in collaboration among all authors. Author FHR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DG, SS and SSK managed the analyses of the study. Author SD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Integration of different enterprises / crop by utilizing farmer’s available resources is one of the best multidisciplinary approaches to boosting farmers’ income from production and economic point of view. In this context, awareness and dissemination of this farming approach are taken as a priority of work with multidisciplinary interventions. One model has been developed on Integrated Farming System Approach in the farmers’ fields on Crop + poultry + fish or Crop + duck + fish in aquatic based production through conducting awareness camp, trainings, trials and demonstrations. This has been developed in the field of one of the farmers namely Shoyeb Hessain, a marginal farmer-cum-rural youth of Jagulipara village in Purba Barddhaman district of West Bengal. Although being a rural youth, he has got a pragmatic view towards latest agricultural technologies and he is keen to learn and as such he was chosen for developing the integrated farming system model in his

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INTRODUCTION

Farming systems refer to obligatory raising of crops, forest and fruit trees, animals including fisheries, piggy and duck farming, sericulture, mushroom, on a given unit of land to increase the productivity and profitability, to upgrade natural resource base and to achieve overall improvement in the environment [1].

“There is no waste”, and “waste is only a misplaced resource which can become a valuable material for another product” in Integrated Farming System (IFS) [2]. Integrated Farming System is a mixed farming system that consists of at least two separate but logically interdependent parts of a crop and livestock enterprises [3]. IFS, as a mixed animal crop system, envisages animal component being raised on agricultural waste products while the animal is used to cultivate the soil and provide manure to be used as fertilizer and fuel [4]. The rural livelihood development and food security at household level in rural India is an important issue, where millions of poor people have been suffering in persistent hunger and malnutrition [5]. Small and marginal land with limited resources and their sustainable utilization are the major issues of the country in the present scenario of the agriculture production system. From green revolution onwards farmers are mostly concentrating on single enterprise based agricultural system that leads to deterioration of soil health, increased risk of crop failure and downward trends of productivity. In this context integration of diversified enterprises / crops by utilizing farmer’s available resources is, arguably, the best sustainable approach from production and economic point of view. Integrated Farming System is archetypical of Farming System Research (FSR) which induces a change in the farming techniques for production maximization while taking care of optimal utilization of resources. [6]. Integrated Farming System is an integrated set of elements / components and activities that farmers perform in their farms under their resources and circumstances to maximize the productivity and net farm income on a sustainable basis [7]. Integration is made in such a way that the product i.e. output of one enterprise / component should be the input for the other enterprises with high degree of complementarily effects (Fig. 1). The authors are in agreement of the view that the rationale of IFS is to minimize the wastes from the various sub systems on the farm and thus it improves employment opportunities, nutritional security and income of the rural people [8].

The modern agriculture emphasizes two more dimensions viz. time and space concepts. Time
concept relates to increasing crop intensification in situations where there is no constraint for inputs. In rain fed areas where there is no possibility of increasing the intensity of cropping, the other modern concept (space concept) can be applied. In space concept, crops are arranged in tier system combining two or more crops with varying field duration as intercrops by suitable modifying the planting method.

Income through arable cropping alone is insufficient for bulk of the marginal farmers. Activities such as dairy, poultry, fish culture, sericulture, bio-gas production, edible mushroom cultivation, agro-forestry and agri-horticulture, etc., on this basis, IFS models have been suggested by several workers for the development of small and marginal farms across the country [9,10,11]. Thus, the concept of Farming system approach can be summarized as it is a holistic approach, complex in nature, interrelated of components, matrix of soils, plants, animals, power, implements, labour, capital and other inputs, influenced by political, economic, institutional and social forces, [12]. The marginal and small holdings invariably keep bovines, cattle and or buffaloes (1-2) along with desi fowls (10-20) in the family backyard or ducks in areas which are coastal or have sufficient water bodies and also reported that sheep are the rare component in mixed farming systems [13]. The introduction of tree crops with agriculture along with the farm based allied enterprises like dairy, goat rearing, apiculture etc. as a risk management strategy to cope up with disasters like long drought season and heavy flood [14].

Indian vision also suggested that the integrated fish farming is a diversified and coordinated system of producing fish and agricultural/livestock produce in fish farms with fish as the main component for maximal utilization of land/water through recycling of wastes and by products, reduced application of fertilizers and feeds and maintenance of a balanced ecosystem [15]. Unlike mixed farming, different farming components in Integrated Farming System (IFS) exist with mutual benefits. Integrated Farming System can be practiced in different way with variable intensity depending on socioeconomic structure, characteristics of soil, choice of the farmers and most importantly the resource availability of farmers. Integrated Farming System has several benefits which include creating job opportunities to the marginal farmers throughout the year as it is an intensive farming, one enterprise may act as insurance to other in case of crop failure, by-product of one enterprise may be used in other and it also improves soil health and fertility in long run [16,17]. Integrated farming system has revolutionized conventional farm structures and practices by promoting a more efficient and sustainable approach to agriculture.
farming of livestock, aquaculture, horticulture, agro-industry and allied activities [18]. It could be crop + fish integration, livestock + fish integration, crop + fish + livestock integration or combinations of crop, livestock, fish and other enterprises [19]. The objectives of this study was to find out the suitability of IFS in rural villages of Purba Barddhaman district and determine the profitability of this approach in comparison to existing farming system and better utilization of the aquatic niche based eco-system.

2. MATERIALS AND METHODS

The study was conducted in Galsi block of Purba Barddhaman district, West Bengal during 2011-12 and 2012-13. Four villages of these blocks were selected where some of the families having pond around one bigha area with adjoining 1.5 bigha land including bund area to improve the existing practice. A total of 21 pond-based system were selected randomly. Two different models, Crop + fish + poultry and Crop + fish + duck along with the existing farmer’s practice (i.e. only fish production) have been replicated in those selected ponds. In each case the land area 1 ha out of which 0.75 ha was pond area and 0.25 ha was cultivable area. To start with, multidisciplinary trainings were conducted and selected families were supplied with tissue cultured banana plantlets; seedlings of vegetables like cauliflower, tomato, chilli etc.; poultry chicks or ducklings; and fingerlings of major carps. A good banana orchard intercropped with vegetables like chili, tomato, brinjal, turmeric was developed in the bund areas along with the composite fish culture. In each replication 30 numbers of ducklings or chicks have been provided.

The model, so developed, was extended to other blocks of Kalna I and II and Purbasthali I and II during 2014. Structured questionnaire was used to get the necessary information about IFS development needed for data analysis in the selected blocks for change in food security and income augmentation

2.1 Food Security Index

Changes in food security of the 250 respondents selected for crop diversification study was measured following the methods of Chen [20] and is given by the following equation,

\[
FSI = \frac{\sum_{i=1}^{N} a_i C_{d_i} + \sum_{i=1}^{N} b_i C_{e_i} + \sum_{i=1}^{N} c_i C_{d_i} + \sum_{i=1}^{N} d_i C_{d_i} + \sum_{i=1}^{N} e_i C_{e_i}}{N}
\]

Where,

FSI = Food security index, \(a = \) Frequency of responses indicating food insecurity (temporal + permanent), \(b = \) Frequency of responses indicating always not enough to eat, \(c = \) Frequency of responses indicating sometimes not enough to eat, \(d = \) Frequency of responses indicating enough but not always the desired food, \(e = \) Frequency of responses enough of the desired food, \(N = \) sample size, and \(C_a \) to \(C_e = \) Coefficients of different adequate food grains, with value 1 indicating food insecurity (temporal + permanent), 2 indicating always not enough to eat, 3 indicating sometimes not enough to eat, 4 indicating enough but not always the desired food and 5 indicating enough of the kinds of desired food.

2.2 Income Augmentation

For calculation of change in income due to adoption of technology, 5 respondents were selected from each cluster through subjective sampling and were questioned for their income under various enterprises in the baseline year of 2014 and present income (December 2018).

3. RESULTS AND DISCUSSION

Firstly, it was observed from the study that manpower engagement was considerably increased in both farming system in comparison to conventional monocropping system particularly due to banana and vegetable intercropping system and was found beneficial for the target group who needed jobs round the year. Poultry and ducks were mostly pastured fed and both pond and cropping land facilitated to supply their feed. Data had been taken from the farm of Sk. Shoyeb Hossain for two consecutive years on productivity of each components and their cost of cultivation as well as return in monetary value. Two year’s data have been pooled and presented in the Tables 1 and 2.

It was observed from the Tables 1 and 2 that farming system of Crop + fish + poultry farming was most suitable in the study area in terms of yield as well as monetary benefit which showed the B : C ratio of 2.42. It also revealed that banana-vegetable intercropping contributed considerably in additional income generation as fish culture remained at per in all the treatments. Income generated during particular year may vary because of seasonal market demand, availability of inputs, labour availability etc.
Table 1. Performance of different components of integrated farming system

| Technology options                  | Fish yield (q/ha) | Tissue cultured banana yield (q/ha) | Vegetables yield (q/ha) | Poultry (eggs/bird/annum) | Duckery (eggs/bird/annum) |
|-------------------------------------|-------------------|-------------------------------------|-------------------------|----------------------------|----------------------------|
| Farmers' practice (Fish farming)    | 20.45             | -                                   | -                       | -                          | -                          |
| Crop+ fish + poultry farming        | 21.25             | 740                                 | 280                     | 174                        | -                          |
| Crop+ fish + duck farming           | 21.75             | 725                                 | 255                     | -                          | 162                        |
| C.D. (0.05)                         | 2.34              | -                                   | -                       | -                          | -                          |

Table 2. Economics of different components of integrated farming system

| Technology options                  | Gross return(Rs) | Net return(Rs) | Benefit : cost ratio |
|-------------------------------------|------------------|----------------|----------------------|
| Farmers' practice (Fish farming)    | 52140            | 24608          | 2.10                 |
| Crop+ fish + poultry farming        | 180680           | 105530         | 2.42                 |
| Crop+ fish + duck farming           | 179005           | 102675         | 2.34                 |

Table 3. Change in food security index (FSI)

| Parametric indicators                  | Kalna I 2014 | Kalna II 2014 | Purbasthali I 2014 | Purbasthali II 2014 | Galsi I 2014 |
|----------------------------------------|-------------|---------------|--------------------|---------------------|--------------|
| Food insecure (temporal+ permanent)   | 13           | 5             | 12                 | 4                   | 18           |
| Always not enough to eat               | 11           | 6             | 11                 | 7                   | 13           |
| Sometimes not enough to eat            | 13           | 6             | 11                 | 8                   | 7            |
| Enough but not always the kind of food desired | 7           | 12            | 9                  | 15                  | 9            |
| Enough of the kind of food desired     | 6            | 21            | 7                  | 16                  | 8            |
| FSI                                    | 2.64         | 3.76          | 2.76               | 3.64                | 2.82         |

Study on changes in food security (Table 3, Fig.2) indicated that over 4 years, there has been augmentation in food security of the respondents. This is due to increase in income owing to adoption of improved technologies and crop diversification. It can be seen from the radar diagram (Fig. 2) that FSI have significantly increased in the clusters of Galsi, Kalna I and Kalna II (Table 4) as compared to the other two clusters of Purbasthali I and II, thus divulged nominal increase in food security. This is ascribable to the increase amount of crop diversification in the blocks of Purbasthali where vegetables are cultivated in large areas.

It was seen that the annual income of the members have increased from Rs. 15000/- to Rs. 135000/- in the 4 eastern clusters and in Galsi cluster it ranged between Rs. 10500/- to Rs 82000/- (Table 4). The income augmentation was well correlated with the land holding (0.95) size of the respondents. When averaged over the entire group of respondents (25 nos.), the income augmentation was found to be 94% over the span of 4 years. Technology adoption and increase in terms of trade, being done in cooperative business mode and without involvement of middlemen, is chiefly ascribable to this income augmentation.

However, it should be clarified here that this increase in income is in nominal terms only and when increase in inflation is taken into account it would be much less in actual terms. Although, this model can be followed towards doubling of farmers income, actually doubling farmers income by 2022 as mandated by government will require rigorous policy measures, like increase in terms of trade further, creation of warehousing for storage, development of irrigation efficiency, enhancement of minimum support price.

Convinced by advantageous aspect of Integrated Farming System model that has been identified and recognized by the District Mahatma Gandhi
Table 4. Income augmentation of randomly selected respondents in the study area

| Enterprise                          | Change in annual income of respondents (Rs.) |
|-------------------------------------|---------------------------------------------|
|                                     | Kalna I                                      |
|                                     | Jogesh Chandra Das (1.2 ha)*                 |
|                                     | Somnath Singh (0.4 ha)                      |
|                                     | Subhendu Mondal (2.4 ha)                    |
|                                     | Arati Das (0.4 ha)                          |
|                                     | Arup Roy (1.8 ha)                           |
|                                     | 2014  | 2018  | Increase | 2014  | 2018  | Increase | 2014  | 2018  | Increase | 2014  | 2018  | Increase | 2014  | 2018  | Increase |
| A                                   | 28000 | 54000 | 26000    | 9500  | 16000 | 6500     | 59000 | 94000 | 35000    | 7500  | 16000 | 8500     | 42000 | 78000 | 36000    |
| B                                   | 5200  | 8500  | 3300     | 1800  | 3200  | 1400     | 0     | 0     | 0        | 2200  | 3200  | 1000     | 7800  | 12600 | 4800     |
| C                                   | 2000  | 3600  | 1600     | 600   | 2200  | 1600     | 0     | 0     | 0        | 5400  | 5400  | 1600     | 16000 | 2600  | 3000     | 3000  | 5400  | 2400     |
| D                                   | 12000 | 18000 | 6000     | 0     | 0     | 0        | 41000 | 58000 | 17000    | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        |
| E                                   | 0     | 2600  | 2600     | 0     | 1500  | 1500     | 0     | 0     | 0        | 3500  | 3500  | 0        | 2900  | 2900  | 0        | 4200  | 4200  | 0        |
| F                                   | 0     | 6500  | 10500    | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        |
| TOTAL                               | 47200 | 86700 | 39500    | 11900 | 22900 | 11000    | 10000 | 160900| 60900    | 11300 | 26300 | 15000    | 52800 | 10200 | 47400    |
|                                     | Kalna II                                    |
|                                     | Naser Seikh (4 ha)                          |
|                                     | Dulan Chandra Pal (3.2 ha)                  |
|                                     | Jagabandhu Pal (1.8 ha)                     |
|                                     | Subhadra Mondal (0.4 ha)                    |
|                                     | Dipali Pal (0.8 ha)                         |
| A                                   | 95000 | 135000| 40000    | 76000 | 108000| 32000    | 40000 | 82000 | 42000    | 8000  | 15000 | 7000     | 16000 | 36000 | 20000    |
| B                                   | 0     | 25000 | 25000    | 10000 | 20000 | 10000    | 0     | 0     | 0        | 12600 | 12600 | 1800     | 1800  | 4200  | 2400     | 4500  | 7000  | 2500     |
| C                                   | 0     | 0     | 0        | 1500  | 6500  | 5000     | 5600  | 8400  | 2800     | 1500  | 4500  | 3000     | 1500  | 5500  | 4000     |
| D                                   | 45000 | 107000| 62000    | 36000 | 92000 | 56000    | 0     | 0     | 0        | 0     | 0     | 0        | 12000 | 25000 | 13000    |
| E                                   | 0     | 8000  | 8000     | 0     | 4500  | 4500     | 0     | 4200  | 4200     | 0     | 2900  | 2900     | 0     | 2300  | 2300     |
| F                                   | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 6800  | 6800     |
| TOTAL                               | 140000| 275000| 135000   | 123500| 231000| 107500   | 52800 | 102000| 61600    | 11300 | 29100 | 17800    | 34000 | 82600 | 48600    |
|                                     | Purbasthali I                               |
|                                     | Gobinda Das (2.5 ha)                        |
|                                     | Sujit Kumar Ghosh (1.4 ha)                  |
|                                     | Bipadbaran Ghosh (3.5 ha)                   |
|                                     | Mojammel Sk. (0.8 ha)                       |
|                                     | Probhat Das (1 ha)                          |
| A                                   | 60000 | 105000| 39000    | 35000 | 65000 | 30000    | 82000 | 135000| 53000    | 18000 | 32000 | 14000    | 24000 | 38000 | 14000    |
| B                                   | 0     | 0     | 0        | 6500  | 10500 | 4000     | 0     | 0     | 0        | 15000| 15000 | 3200     | 3200  | 6500  | 3300     |
| C                                   | 0     | 6000  | 6000     | 2500  | 4500  | 2000     | 0     | 0     | 0        | 1200 | 4500  | 3300     | 0     | 4500  | 4500     |
| D                                   | 45000 | 65000 | 20000    | 0     | 0     | 0        | 25000 | 55000 | 30000    | 0     | 0     | 0        | 0     | 0     | 0        |
| E                                   | 0     | 0     | 0        | 3500  | 3500  | 0        | 0     | 0     | 0        | 2300 | 2300  | 0        | 5600  | 5600  | 0        |
| F                                   | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        | 0     | 0     | 0        |
| TOTAL                               | 111000| 176000| 65000    | 44000 | 83500 | 39500    | 107000| 205000| 98000    | 22400 | 45300 | 22900    | 24000 | 48100 | 24100    |
|                                     | Purbasthali II                              |
|                                     | Praneshwar Bhowmik (2 ha)                   |
|                                     | Bishwajit Das (0.8 ha)                      |
|                                     | Rakhal Das (0.6 ha)                         |
|                                     | Majibar Sk. (0.4 ha)                        |
|                                     | Banamali Orao (0.4 ha)                      |
| A                                   | 48000 | 94000 | 46000    | 28000 | 42000 | 14000    | 22000 | 34000 | 12000    | 12000| 22000 | 10000    | 6000  | 15000 | 9000     |
| 138 |
| Enterprise | Change in annual income of respondents (Rs.) |
|------------|---------------------------------------------|
| B          | 0 6500 6500 0 4500 4500 0 2500 2500 1400 4500 3100 0 2500 2500 |
| C          | 5600 9000 3400 1800 8500 6700 1600 7500 5900 3500 5500 2000 0 6500 6500 |
| D          | 0 12000 12000 0 0 0 0 0 0 0 0 0 0 0 0 |
| E          | 0 3400 3400 0 5000 5000 0 5000 5000 0 3200 3200 2200 5600 3400 |
| F          | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 |
| TOTAL      | 52800 100200 71300 29800 60000 30200 23600 49000 25400 16900 35200 18300 8200 29600 21400 |

**Galsi**

| ParamesariBagdi (0.2 ha) | ChanchalaDeshali (landless) | RupaDeshali (Landless) | RupaMondal (0.2 ha) | RokeyaKhatun (2.2 ha) |
|--------------------------|-----------------------------|------------------------|---------------------|------------------------|
| A                        | 6000 12500 6500 0 0 0 0 0 0 8000 17000 9000 44000 94000 50000 |
| B                        | 4500 6500 2000 4200 8500 4300 0 2500 2500 0 0 0 0 0 5500 5500 |
| C                        | 2800 8000 5200 2800 9500 6700 2400 4400 2000 0 6500 6500 5600 12000 6400 |
| D                        | 0 8000 8000 0 0 0 0 0 0 0 0 0 0 0 5000 5000 |
| E                        | 0 4500 4500 0 5000 5000 0 1500 1500 0 5500 5500 0 4500 4500 |
| F                        | 1200 6500 5300 0 10500 10500 0 4500 4500 1200 8500 7300 0 10600 10600 |
| TOTAL                    | 52800 100200 31500 7000 33500 26500 2400 12900 10500 52800 100200 28300 52800 100200 82000 |

A: Crop production; B: Goatary; C: Poultry/duckery; D: Fisheries; E: Other enterprise (Vermicompost/mushroom); F: Value addition/rural crafts; *Figures within parenthesis indicate land holding size
Fig. 2. Change in food security index in the study area

National Rural Employment Guarantee Act (MGNREGA) Cell and had been taken up in MGNREGA Convergence Programme which has been replicated in selected 200 ponds recently excavated under that scheme in the district where the authors of the article has been acting as implementing scientists. Many workshops have been conducted on the methodologies for these interventions to all the beneficiaries of the different areas where those ponds were excavated. Self Help Groups and officers of the line departments of the district involved in the convergence programme of MGNREGA of the district.

4. CONCLUSION

The important objective of this study was to analysis the reality and ground truth of integrated farming system in comparison to present traditional farming system and emphasizes to apply this sustainable integrated farming system for the rural livelihood development. The most notable advantage of utilizing low-cost/no-cost material at the farm level for recycling is that it will certainly reduce the production cost and ultimately improve the farm income considerably. It is no doubt that integration of different enterprises is the best possible option for better utilization of available resources for small and marginal farmers for better and sustainable income. The study also revealed that socio-economic of Indian farmers can be improved by some margin if IFS is adopted location specifically. Further research work need to be initiated for identifying and integration of region specific available resources.

CONSENT

As per international standard or university standard, respondents’ written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh G. Farming systems options for sustainability of natural resources. (In:) Proceedings of Symposium on “Alternative Farming Systems: Enhanced income and employment generation options for small and marginal farmers”. (Eds. A.K. Singh, B. Gangwar and SK Sharma), FSR held at Project Directorate for Cropping systems Research, Modipuram. 2005;57-64
2. FAO. China. Recycling of organic wastes in agriculture. FAO Soil Bull. 1977;40.
3. Okigbo BN. Major farming systems of the lowland savanna of SSA and the potential for improvement. In: Proceedings of the IITA/FAO workshop, Ibadan, Nigeria; 1995.
4. Jayanthi C, Rangasamy A, Chinnusammy C. Water budgeting for components in lowland integrated farming system. Agricultural Journal. 2000;87:411-414.
5. Mistri B, Majhi K. Problems and Prospects of Agriculture in BanagramMouza, PurbaBarddhaman, West Bengal. Indian Journal of Spatial Science. 2015;6(2):47-55.

6. Jayanthi, C. Integrated farming system: A path to sustainable agriculture. 2nd edition, Published by department of Agronomy, Directorate of Soil and Crop management studies, Tamilnadu Agricultural University, Coimbatore. 2006;1.

7. Singh RP. Ratan. Farming system approach for growth in Indian Agriculture. Lead paper in: National seminar on Enhancing efficiency of Extension for sustainable agriculture and livestock production, Indian Veterinary Research Institute, Izatnagar; 2009.

8. Panke SK, Kadam RP, Nakhate CS. Integrated farming system for sustainable rural livelihood security. In: 22nd national seminar on Role of Extension in Integrated Farming Systems for sustainable rural livelihood, Maharashtra. 2019:33-35.

9. Rangaswamy, A., Venkataswamy, R., Premsekhar, M., Jayanthi, C., Palaniappan, S.P. Integrated farming system for rice based ecosystem. Madras Agricultural Journal. 1996; 82 (4): 290-293.

10. Behera, U. K., Mahapatra, I. C. Income and employment generation of small and marginal farmers through integrated farming systems. Indian Journal of Agronomy. 1999; 44(3):431-439.

11. Tejeswara Rao, K., Srinivasa Rao, M. M. V., Patro, T. S. S. K. AICRP on Integrated Farming Systems. Agricultural Research Station, Vizianagaram, AP, India. Int. J. Curr. Microbiol. App. Sci. 2019; 8(09): 2629-2642.

12. Kareem MA. Farming systems approach. Web resource; 2002.

13. Chawla NK, Kurup MPG, Sharma VP. Animal Husbandry. State of Indian farmer. A millennium study, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi and Academic Foundation. New Delhi; 2004.

14. Thamizoli PR, Rengalakshami K, Senthilkumar, Selvaraju T. Agronomic Rehabilitation and Livelihood Restoration of Tsunami Affected Lands in Nagapattinam District of Tamil Nadu. M.S.Swaminathan Research Foundation Chennai. 2006;31.

15. Vision KVK, Assam Agricultural University, Darrang, Mangaldai. 159-10. Vision 2030, 2011d. Central Soil Salinity Research Institute (CSSRI), Karnal. 2011;15.

16. Olele NF, Nwede FU, Agbogidi OM. Role of Integrated Farming System in Agricultural Development in the Delta Region of Nigeria. Delta Agric. 1999;6:128–134.

17. Ugwumba CAO, Okoh RN, Ike PC, Nnabuife ELC, Orji EC. Integrated farming system and its Effect on Farm Cash Income in Awka South Agricultural Zone of Anambra State, Nigeria. Am-Euras. J. Agric. and Environment Sci. 2010;8(1):1-6.

18. Chan GL. Integrated Farming System. What does Integrated Farming System Do?. Available:http://www.scizerinm.org/chanarticle.htm. 2006

19. Tokrishna R. Integrated Livestock-Fish Farming System in Thailand. Available:http://www.fao.org/docrep/004/ac155e/AC155E13.html.2006

20. Chen SK. The establishment of evaluation and indices system for Chinese sustainable development. World Environment. 2000;1-9.