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Comparative study and representation of bio-resource flow diagram and recycling in different farming system – A preview

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ABSTRACT

The integrated farming system (IFS) based interventions are need of the present day agriculture specially for marginal and small farm holders struggling for food, nutritional and economic security for farm and farm family. The study of bio-resource flow is one of the potential option to know about efficiency of IFS based interventions to cater both economic and ecological requirements from IFS. The preview describes the concept of bio-resource flow and its comparative analysis in rainfed versus irrigated IFS, conventional agrochemical based versus organic IFS and organic IFS versus natural farming. The comparative study of bio-resource flow will provide scientific fact based opportunities for enhancing bio-resource flow and bringing efficiency I n IFS; while diagrammatic representation will make it possible to convey both quantitative and qualitative information about IFS in more effective way in fewer words. The conventional agrochemical based IFS have more freedom leading to expected more efficiency of bio-resource flow; while it is being constrained by outflow of biomass produced from the system and adverse residual effect of agrochemical and tillage intensive practices. In case of organic IFS, the organic nature of input and more freedom than natural farming for selection enterprises is positive point along with long term sustainability; while expected lower productivity and requirement of certification for compensating lower yield through higher market prices are major consideration. The rainfed and irrigated agriculture are conditional by the agro-climatic consideration which are difficult to amenable and need to address by selecting suitable enterprises irrespective of comparative productive capacity and efficiency of bio-resources.

Keywords- Integrated farming system, organic farming, natural farming.

The farming system in getting and should be highlighted rather than cropping system alone due to consistent realization about farming based livelihood system in case of marginal and small farmer rather than just increase in per unit and national productivity from arable crop cultivation Kumar et al., 2025). The cropping system based interventions will not be self-sustainable due to the fact that, nutritional and economic security of farm family will not be addressed by cropping system alone. The incorporation of multiple enterprises including plants and animals origin will helps in addressing these concerns which is widely realized in different agro-climatic zone based integrated farming

system models (Gill et al., 2009). The farming system in amended with two type of resources viz., natural and artificial resources; while these resources are also classified as in-situ and ex-situ resources. The resources are utilized for production of net and gross primary products, being stored in system in different pools or partly being recycling or taken out of the system as economic produce to be used in another system. This recycling will be across different enterprises involved in system and need to be presented in legitimate way for presenting the information in diagrammatic form. Such representation of information in diagrammatic form is considered as bio-resource flow diagram. The bio-resource recycling is the product of amount of bio-resource available for recycling and availability of most efficient system of recycling. The efficiency of bio-resource flow is affected by different stresses such as insect-pest, diseases, weeds as well as different abiotic factors. Besides that underperformance of crops/animal due to improper management and sub-optimal input supply will also adversely affects bio-resource recycling potential. Besides that inefficient utilization of bio-resources such as burning crop residue, wastage of farm animal urine and improper handling of animal excreta as well as use of less efficient methods or enterprises in bio-resource recycling.

The bio-resource flow diagram is the diagrammatic or pictorial representation of energy and biomass flow among the different components/ enterprises of farming system. It indicates both quantity and quality of biomass and energy. The direction of flow is indicated by point arrow from contributing enterprise to the gaining enterprise/ enterprises; while the thickness of arrow is used to indicate the amount of flow. This diagram is important in order to understand interaction among different enterprises in the farming system. The farm household is the centre of all the activities as well as basic unit of farming system and hence all enterprises are interacting with farm household. The input application and returns from all enterprises area major form of interaction besides providing food and nutrition. The bio-resource flow diagram is one of the important tool of participatory rural appraisal and used for indicating the complex interaction among different component. The bio-resource flow diagram should be

- More efficient to reduce the wastage,
- Sustainable and valid in long term,
- Fewer footprints on ecosystem and very less negative impact on ecosystem,
- Generating economics benefits to the farmers with higher B:C ratio,
- Should be mostly in-situ with less dependence on external resources,
- Have wider applicability and ease to follow
- Should be comparable with other farm enterprises and having complimentary/ supplementary and synergistic relation with other enterprises.

Significance of bio-resource flow diagram

1. Bio-resource flow diagram shows the direction and quantum of energy and biomass flow.
2. Determination of energy efficiency as well as wastage of resources can be judged from the bio-resource flow diagram.

3. It helps in easy and effective presentation of complex interaction among enterprises of farming system and
4. It helps in comparison and preparation of model farming systems for different locations.

Bio-resource flow diagram for dryland farming system

In present bio-resource flow diagram, poultry, cereal crops, goat and sheep domestication, compost pit and agroforestry are the components (Figure 1). The crops component imparting grains and cash earning to farm family, feed and bedding material for poultry, substrate for compost pit, mulching material and compost to agroforestry, and feed for goat and sheep unit. This enterprise getting capital/ investment from farm family, manure from goat and sheep unit and poultry and mulching material and leaf manure from agroforestry. The input for compost pit is from crop component, poultry enterprise, sheep and goat enterprise and agroforestry, indicating the entire component impart the input to compost unit which is mainly a waste material or by-products generated in each component. The output of compost pit is used by crop and agroforestry component as a source of nutrition. This signify the role of compost pit in converting the by-produce or waste generated in each component in to valuable input for fertility enhancement of soil in farming system. In case of goat and sheep raring, they are feed on by-produce of crop and agroforestry and convert them in useful energy such as milk, meat and hide/skin/wool; while unutilized matter (Excreta) is circulated in through compost pit. This enterprise serve as high capital liquid for farm household due to their reproduction capacity and ready for marketing in short time. As goat and seep require less feeding and housing requirement, they will be considered as important component in dryland farming system. The crop cultivation duration is rainfed agriculture is depending upon the rainfall water availability; hence conservation of runoff water is most important activity. This will helpful in increasing the length of growing season as well as reduce the chances of crop failure and increase the total biomass production. The higher biomass production needs to insuring in order to meet feed and fodder demand of poultry, sheep and goat.

Bio-resource flow diagram for irrigated farming system

The bio-resource flow diagram in irrigated farming system is much more complex than rainfed farming system due to involvement of more number of enterprises as well as more intensification of activity of each enterprise (Figure 2). For example, in case of crop component there is wide range of choice without any constraints of water availability and therefore intensification of crop component in terms of intercropping, mixed cropping, sequential cropping, etc. can be possible. This intensification will be helpful in generating more output in the form of cash returns as well as increase the biomass production which will be serves as input/ feed/fodder for animal components. The crop component serves as a foraging area for bee and in terms bee will be acting as pollination agent for crop. The growing of sunflower, mustard and some flowering plant for flower production will meet the need of bee for collection of nectar. The commercialization of most on the enterprises is one of the potential is one of the distinct feature due to high capital investment, large size/ activity of each enterprise, capacity to produce high output/ marketable surplus and need to commercial scale marketing rather than just home consumption. The enterprises such as dairy farming, poultry, and fish farming are the examples for commercial scale of enterprises.

Comparison of bio-resource flow indifferent types of production systems

The difference between bio resource flow between conventional agrochemical based IFS (CF-IFS) and organic farming based IFS (OF-IFS) is explained by restriction on origin of inputs, quantity of resources available for recycling, efficiency of recycling, impact of recycling on natural resources, potential for recycling and outflow of biomass from system. The outflow of CF-IFS is comparatively higher which are the results of use of unrestricted use of artificial resources irrespective of their natural (organic or inorganic) as well as at the cost of natural resources and their degradation. This makes more biomass available for recycling as compared to OF-IFS; while outflow as well as economic use of biomass from the system is higher in CF-IFS which act as constraints for recycling of biomass within the system. Increase in use of animal based enterprises and overall increase in number of enterprises such in will be potential solution (Figure 2). In case of OF-IFS the biomass recycling is expected to be higher in order to fulfil the need of input requirement through biomass recycling units. Besides that small ruminants and poultry as well as seasonal fish rearing in farm pond will be another potential avenue for increasing biomass recycling within the system. The adverse impact of recycling on natural resources on is minimal in OF-IFS due lack of use of any agrochemicals with their residual effects and diversified cropping system as well as other enterprises without any extractive farming activity unlike in CF-IFS. In case of CF-IFS due to increased number of activities of animal based enterprises efficiency of bio-resource recycling can be increases through biogas plant with addition returns in the form of biogas; while in OF-IFS due to expected less activity of each enterprise the suitability of biogas plants with number and size of biogas plant in under consideration. The capital gain in case of CF-IFS and agro-chemical free certified organic produce in case of OF-IFS are potential economics points for consideration; while lack on comparability due to diverse resource involvement are the potential interventions. The natural resources health is much better in OF-IFS compared to CF-IFS even though the productivity is less. This makes difference in stability and sustainability of both systems with OF-IFS found superior in both attributes.

In case of OF-IFS and natural farming system, organic natural of inputs is common; while restriction on use of only in-situ inputs distinguishes NF from OF-IFS. Besides that role of animal component is restricted only to cow (region specific local cow) in NF; while OF-IFS has advantages of wider range of animals. There is great scope for intensification of OF-IFS with increase in number of activities and enterprises; while NF itself is a farming system comprises of three components viz., crops, trees and animal. Therefore only crops and tree components can be considered for intensification and diversification. The NF is umbrella term encompassing different types of traditional production system, such as *Natueco* farming, *Agnihotra* farming, biodynamic farming, zero budget natural farming, etc. therefore brining uniformity is challenge and now being addressed through institutional and policy efforts to have an integrated concept of natural farming scenario at national level in India. Besides that bio-resource flow through OF-IFS has wider scope across the regions; while NF has scope in niche area at present and expected to expand in future. The economic efficiency of bio-resource flow is superior in OF-IFS and can be market produce as certified organic produce; while in NF, economic superiority as well as certification is still not comparable and competitive as that of OF-IFS. Besides that OF-IFS have freedom for selection of animal based enterprises as well as other enterprises with less with NF. Along with that, preparation of in-situ

fermented bio-inputs in NF versus use of purchased organic input in OF-IFS is another point to investigate. Das *et al.* (2009) reported that rice equivalent yield of integrated organic farming system (crops + dairy + fishery + nutrient cycling] 19.8 t/ha which higher than rice–fallow system (4.0 t/ha) and rice–vegetables (on 30 % area) (6.72 t/ha). They also found that, net returns of ₹ 71,442 per year as compared to ₹ 15,700 and ₹ 24,518 per ha respectively in rice–fallow system and rice–vegetables [on 30 % area]. In another study Ponnusamy and Kousalya Devi (2017) reported that, net returns from crop + dairy + poultry + fishery farming system is ₹ 57,530 per ha which is higher than crop + dairy and crop + dairy + poultry by ₹ 49,650 and 44,850, respectively. Panpakdee and Hoaihongthong (2025) reported that horizontal knowledge transfer play important role in adopting IFS in organic farmers; while fragmented land holding, degraded lands and inadequate institutional support mechanism are major constraints in adoption. This indicates the OF-IFS is well suited in different environment; while NF is need to be specified for different ecological condition.

CONCLUSION

In nutshell, the bio-resource flow diagram is potential tool for understanding relation between different enterprises and comparative study of different IFS based interventions for their productivity capacity as well as resource recycling efficiency. Besides that, the quantitative description of relations is also possible which make more sense to the bio-resource diagram. The comparative assessment of organic farming based IFS and natural farming is future potential for bio-resource diagram considering increased attention on natural farming at policy and institutional level as well as at farming society level driven by pioneer workers and farming society initiatives.

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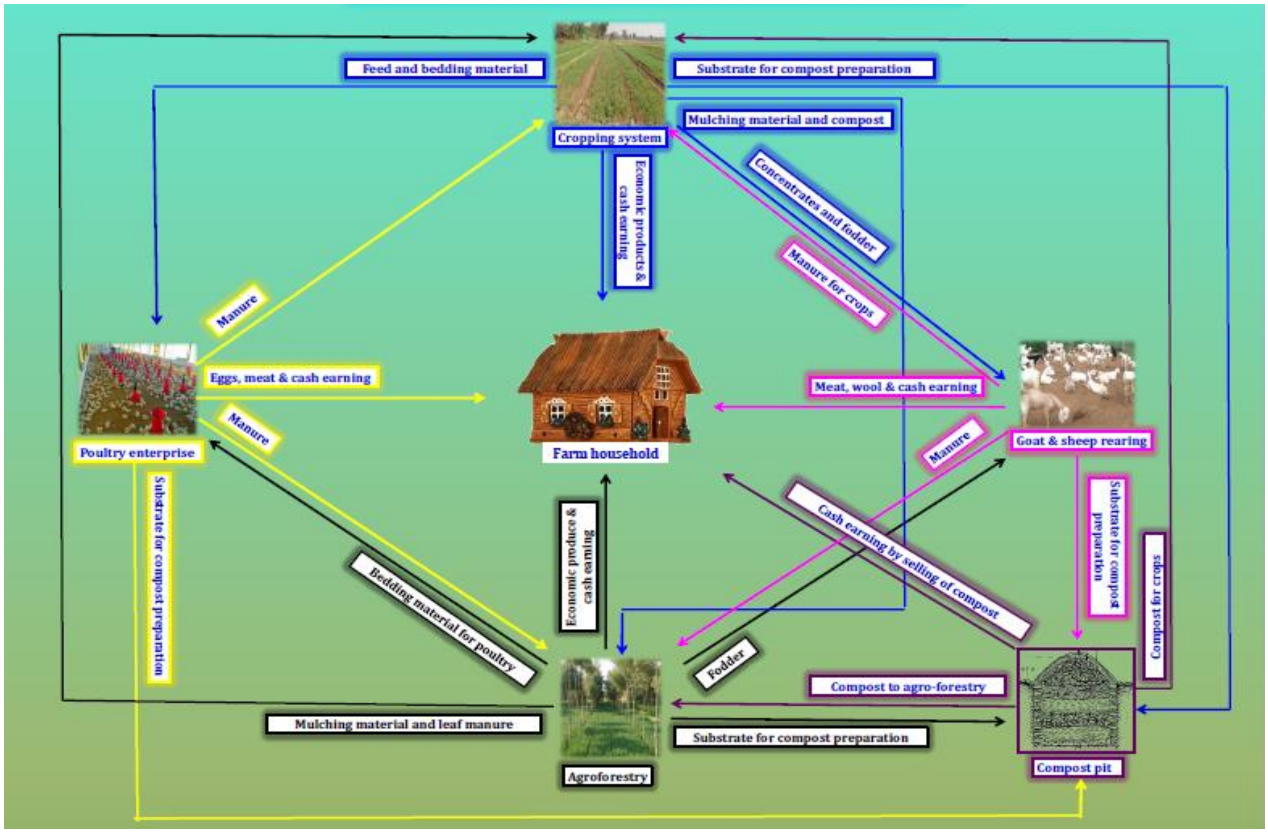

Figure 1. Bio-resource flow diagram of rainfed farming system

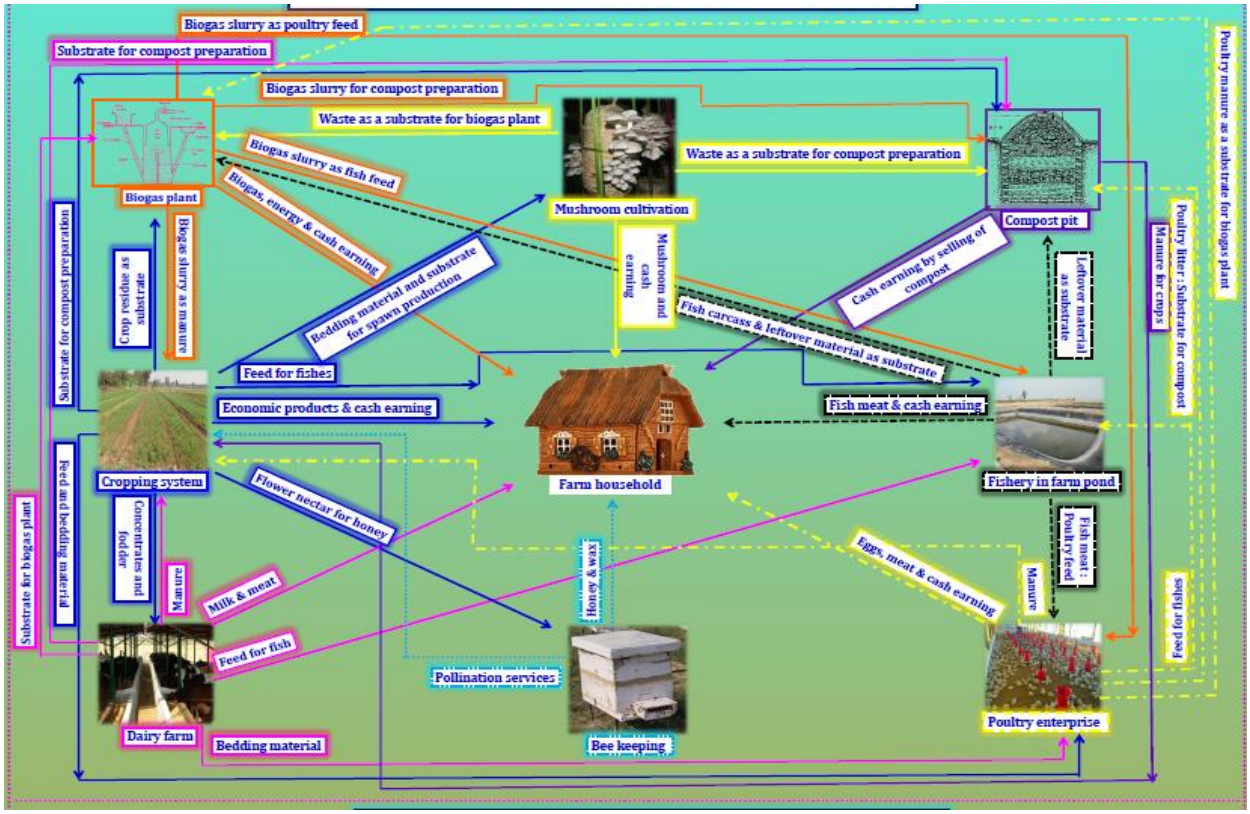

Figure 2. Bio-resource flow diagram of irrigated farming system