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The Potential of Integrated Farming System to Supply Feed and Fodder for Dairy Cattles and Evaluation of its Performance

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Abstract

In Andaman and Nicobar Islands livestock sector performance is severely limited by fodder and feed supplies especially during dry period (January-April). Consequently livestock are left free to graze in the field. In this context, green fodder cultivation and promotion of selected grasses besides proper utilization of rice straw assumes greater significance to support livestock production in the island. The present study was carried out to, assess the feed and fodder production potential of integrated farming system in coastal lowlands. The study showed that IFS system could supply 2,609 kg rice straw and 12,557 kg green fodder enabled by production of Bajra Napier hybrid + cowpea, fodder sorghum, maize straw (sweet corn) and green foliage of pulses. This would supply 35 kg of green fodder and 17 kg of dry fodder per day. Supplemented with 2.0 – 3.0 kg of concentrate, this would be sufficient for two dairy cattle. This greatly improved the performance of the dairy unit (1750 L/lactation/animal) with the net return of Rs. 1,35,090/- that constitute 48.5% of total farm revenue. Further feeding the animals using the on farm produced feed and fodder resulted in reduced parasitic load and other stresses on the animal. Up scaling this model to the entire farm households would meet the projected demand of the Island production by increased production from the current level.

Keywords: *shortage of feed, dairy production, rice straw, crop residues, IFS, Island ecosystem*

Introduction

Dairying in India is an important livelihood activity and over 80% of milk production in the country is by smallholders. In dairy, feeding accounts for more than 70% of the total cost of milk production and it directly or indirectly affects the entire livestock sector, including animal productivity, health and welfare and the environment (Makkar, 2016). According to an estimate of National Commission of Agriculture, there is a deficiency of concentrates and green fodders in India (Kamra, 1998; DES, 2019). Farmers practicing specialized fodder based production system are limited and most of the grazing lands are public property or forest. In Andaman Islands, dairy and goat are the major livestock reared by the small and marginal land holders. The dairy contribute significantly, both in number as well as in production of milk. The milk production in the Islands decreased from 26,000 tons in 2012 to 16,990 tons in 2018 and per capita milk availability in these Islands is only 110 gm/ day as against the national average of 337 gm/day. The low productivity could be due to poor and imbalanced nutrition, lack of green fodder mainly during dry period (January to March), infertility and prevalence of parasitic and gastrointestinal parasitic diseases in dairy cattle (Perumal *et al.*2018).

With projected increase in population and development of tourism in the Islands, the productivity of the livestock needs to be doubled to cater the demand of meat, milk and other livestock products. Any increase in the productivity should come by effectively utilizing the available resources but without negative impact on the environment (Kundu *et al.* 2006). In the small holder farming systems prevalent in these Islands, the production of forage and fodder is often a sidelined activity and not being practiced as integral part of farming. The animals are allowed for grazing in the open grasslands, or the animals are fed with grasses and legumes which grow voluntarily on the field bunds or in waste or fallow lands. Fodder shrubs and trees may or may not be present on field bunds. The locally available feed resources are the major driving force for improving productivity of animals in developing countries like India. To maximize profitability from the dairying, one need to ensure that the dairy animals receive required quantity of protein,

energy, minerals and vitamins in a cost effective way, preferably from locally available feed resources such as local grasses, natural forages and green fodder (Hossain *et al.* 2017).

In the coastal and lowlands of this island the availability of feed and fodder is severely constrained particularly during dry season. In these areas integrated farming system (IFS) provide the means for addressing the issues of livestock farming in the islands by providing opportunity for production of feed and fodder and efficient waste recycling for increasing the farm productivity. Thus in this study, we made an assessment of feed and fodder production potential of IFS based on long-term field experiment with the aim to enhance the production of dairy animals in smallholder farms under island conditions. Further an attempt was made to qualitatively assess the impact of providing on-farm produced feed and fodder to the dairy animals on production and animal health.

Materials and Methods

The study was conducted during 2014 to 2018 in an area of 0.75 ha at Field Crops Research Farm, Bloomsdale of ICAR- Central Island Agricultural Research Institute, Port Blair. The crop components were allocated an area of 0.65ha with 0.35ha used for raising different rice based cropping systems viz., rice (*Oryza sativa L.*) – maize (*Zea mays L.*), rice (*Oryza sativa L.*)- green gram (*Vigna radiata)*, rice (*Oryza sativa L.*) – sorghum (*Sorghum bicolor*) and rice (*Oryza sativa L.*) – vegetables (okra/ brinjal/cowpea). In 0.30ha vegetables were grown on the beds and rice-fish in the sunken furrows of BBF. Fodder crops (Bajra-Napier hybrid and cowpea) were grown in an area of 500 m^2 on a bed, field bunds and on the slopes of the beds in BBF system.

The livestock component comprised of two Crossbred Holstein Friesian (HF) cows integrated with other components since April 2014. The green fodder requirement of the animals was met from fodder crops grown on the beds, fodder sorghum from rice-sorghum rotation, and crop residues such as rice straw, maize stover and other crop residues. On an average 25-30 kg green fodder was given to each animal every day, besides some concentrate feed to maintain the nutritional status of the dairy unit. The lactating animals were fed with 1 kg concentrate for every 2.5 to 3.0 l of milk yield along with 2 kg dry fodder while calves and heifers were fed with 1 kg feed. The animals were allowed for restricted grazing within the farm on rotational basis in different field units in the morning after milking to keep the animals active. Proper weeding of unwanted plants and cleaning of field bunds were carried out periodically. Standard livestock management practices were followed to provide healthy and hygienic conditions for animals. During the experimental period the animals were routinely observed for health status and the details were recorded.

Results and discussion

Fodder production

Fodder and feed are the most valuable and cheapest sources of food for livestock. They are the rich source of energy, mineral nutrition, carbohydrates and protein. In India, the three major sources of fodder supply are crop residues, cultivated fodder and fodder from common property resources like forests, permanent pastures and grazing lands. In the Islands, the cultivated fodder production is very limited, accounted only 10ha in 2006 (Kundu *et al.* 2006). As the constant supply of good quality forage in sufficient quantities is a basic necessity in livestock farming, fodder requirement of dairy animals without affecting the production of major crops such as rice, vegetables and other food crops can be achieved by proper planning and crop allocation through farming systems approach. The study showed that on an average IFS system could produce 2,609 kg rice straw and 12,557 kg green fodder besides other crop waste i.e 583 kg of chaffy grains in a year (Table 1).

In addition to rice straw, green fodder produced in IFS includes the Bajra Napier hybrid, cowpea, fodder sorghum, maize straw (sweet corn), green foliage of pulses, vegetables (cow pea, French beans, cauliflower, okra, brinjal) and fodder from the slopes of the beds of BBF system. BN hybrid is available throughout the year besides seasonal availability of crop wastes. After rice, sorghum (TN local) was grown as a fodder crop during January – March in area of 1500 m^2 with average

production of 38.4 t ha^{-1}. By adjusting the sowing date and staggered planting, the green fodder availability can be extended even during dry months of April – May with one or two irrigations. In normal rainfall years, the ratoon crop of sorghum can be harvested till May. At times fodder was obtained from subabul *(L. leucocephala)* and other MPT located on the boundary. Besides, there are other crop residues like sweet corn straw, pulses and vegetables which are available during February to March at the time of harvesting of these crops.

Table 1: Amount of feed and fodder produced in IFS system (0.75ha)

Sl. No.	Item	On farm production of dry and green fodder (kg)			Mean (kg)
		2015-16	2016-17	2017-18	
1	Rice straw	2,185	2,705	2,938	2,609
2	Green fodder	10,390	12,077	15,205	12,557
3	Chaffy grains	750	555	445	583
4	Agro-forestry	350	450	380	390

Composition of rice straw

Rice straw is the only dry fodder produced in the system and it is available after harvest of rice in November. In the present study medium and long duration rice varieties were grown during July to November. With proper drying and storage the rice straw was fed to the animals throughout the year and it was sufficient to supplement the green fodder requirement of a herd of 3 adults. The chemical composition of paddy straw varies between varieties, growing seasons and agronomic management. In general higher nitrogen and cellulose contents are found in early season rice compared to others. Paddy straw contains 25-45% cellulose, 21-32% hemi-cellulose, 2.0-5.8% lignin and 3.5 – 4.7% crude protein with low nitrogen, vitamins and minerals (Table 2). Feeding cattle with high quantities of silica hinder the nutrient availability to rumen microbes and eventually limits the necessary nutrient uptake for a satisfactory performance of the animals (Van Soest PJ (2006). Such materials should be nutritionally improved by further processing of the straw (silage / hay making) or mixing with other fodder / concentrates. Presence of anti-nutritional factors like silicates and oxalates in rice straw with low nutritive value, poor palatability and limited ruminal degradation (as in-vitro dry matter digestibility) render paddy straw insufficient to support nutrient requirement of the animals without addition of nutritional supplement (Sharma *et al*., 2001). In corroboration with the previous studies, rice straw harvested from the system was of required quality and can be safely fed to the ruminants supplemented with concentrate feed and green fodder.

Table 2: Chemical constituent and nutrient composition of rice straw

Sl.No.	Chemical composition	Values (range)
1	Dry matter (g kg^{-1} FM)	865 - 930
2	Mineral matter (g kg^{-1} DM)	112 - 252
3	Hemicellulose (g kg^{-1} DM)	210 - 325
4	Cellulose (g kg^{-1} DM)	250 - 456
5	Lignin-sa (g kg^{-1} DM)	20.0 - 58.5
6	Crude protein (g kg^{-1} DM)	35.6 - 47.5
7	C (nitrogen fraction) (g kg^{-1} CP)	125 - 230

Sl.No.	Chemical composition	Values (range)
	Nutrient composition (%)	
8	N	0.4 - 0.7
9	P_2O_5	0.15 - 0.29
10	K_2O	0.95 - 2.1
11	Ca	0.63 – 2.21
12	Mg	0.82 – 2.35
13	Fe	0.15 – 0.56
14	Mn	0.08 – 0.14
15	Zn	0.04 – 0.12
16	Cu	0.05 – 0.12

Assessment of feed and fodder availability

Given the average nutritional composition of the rice fodder samples evaluated, it is suggested that their use for feeding cross breed or high yielding animals, as the only food source, is not sufficient to meet the maintenance requirements of the animals (Sarnklong *et al*., 2010). However, this feed presents relevant potential for strategic use as part of the diet of animal categories with lower nutrient requirements in times of food shortage, as well as to preserve the body condition of the animals, intensify the production system, and still allow a better quality of postpartum nutrition. The variation in the nutritional value of rice straw evaluated in this study was explained by the effects of rice varieties, manuring, and other agronomic practices. Previous research has also identified variations in the nutritional value of rice straw due to difference in rice genotypes and crop development cycle (Santos, 2010) and grain production (Vadiveloo, 2003).

Table 3: Status of on-farm production and fodder requirement for two dairy animals in IFS

Month	Availability (kg)		Per day availability		Requirement per day (kg / two animals)			Remarks
	Green fodder	Dry fodder	Green fodder	Dry fodder	Green fodder	Dry fodder	Concentrate	
January	1046	521	35	17	30-50	10-12	3.0 – 6.0 (5 -6.0 kg during lactation)	All are sufficient
February	1046	521	35	17	30-50	10-12	3.0 – 6.0	All are sufficient
March	1046	521	35	17	30-50	10-12	3.0 – 6.0	All are sufficient
April	1046	521	35	17	30-50	10-12	3.0 – 6.0	All are sufficient
May	1046	521	35	17	30-50	10-12	3.0 – 6.0	All are sufficient
June	1046	-	35	-	30-50	10-12	3.0 – 6.0	Sufficient GF Preserved / silage dry fodder along with others

July	1046	-	35	-	30-50	10-12	3.0 – 6.0	Sufficient GF Preserved / silage dry fodder along with others
August	1046	-	35	-	30-50	10-12	3.0 – 6.0	Preserved / silage dry fodder along with others
September	1046	-	35	-	30-50	10-12	3.0 – 6.0	Deficit of dry fodder, met by more concentrate
October	1046	-	35	-	30-50	10-12	3.0 – 6.0	Deficit of dry fodder, met by more concentrate
November	1046	-	35	-	30-50	10-12	3.0 – 6.0	Deficit of dry fodder, met by more concentrate
December	1046	-	35	17	30-50	10-12	3.0 – 6.0	All are sufficient
Total production	12,557	2607						Feed, fodder, concentrate requirement is met

* 1 kg paddy straw can replace 4-5 kg of green fodder on dry matter basis, Concentrate, and green and dry fodder requirements are based on National Dairy Development Board recommendation for adults

As indicated in the table 3, when the animals are supplemented with rice straw (2 kg/animal/day), the green fodder requirement is substantially reduced from 27,375 kg to 16,425 kg year^{-1}. This deficit can be further reduced by supplementing with excess dry fodder (400 kg) available in the system or further augmented by planting one or two fodder trees (*Sesbania sesban, S. grandiflora*) on field boundaries or near the sheds. Such an increased fodder production was achieved earlier by growing short duration forages in the gap period of the prevalent crop sequence which is a standard practice in irrigated areas. For example in the wheat-sorghum-maize-bajra sequence, forage crop mixtures like maize +cowpea, sorghum + cowpea or bajra + cowpea were grown in the gap period that exists between April and June which with an yield of 35–40 tonnes/ha, without affecting main crop (Lal and Tripathi 1987).

Performance of dairy unit under IFS

The clinical observations of the dairy animals fed with feed and fodder produced in the IFS as against the free ranching animals are presented in table 4. The productivity of the animal is negatively affected by the combination of abiotic and biotic stresses. It was observed that most of the parasitic infections are acquired during grazing and intermingling with other animals. In contrast, dairy animals reared in the IFS, are fed with suitable mixture of feed/fodder were less infected with these parasites. Similarly plant poisoning and aflatoxicosis are more prevalent among the freely grazing animals. Further, walking stress and bloat are more prevalent in freely ranching animals. Thus on-farm production and feeding of animal with dry and green fodder are less prone to these stresses as compared to the free ranching animals. This provides more scope of increasing the livestock production relying on the good health of animals that also improves the stability of IFS production.

Table 4: Effect of IFS on animal health (based on qualitative observation)

Sl.No.	Biotic (disease and pest) and Abiotic stresses	Stress level		Remarks
		Dairy animals in IFS	Free ranching animals	
1	Helmintic parasite	1	3	Animals graze in open place or nearby water bodies (as snail is the intermediate host) suffer more helmintic infestation.
2	Leptospirosis	1	2	Freely grazing animal in paddy field and other places suffer leptospirosis and spread by rat
3	Hump sore	0	2	Animals reared in pasture system have suffered more than in backyard system
4	Tick infestation	0	3	Tick infestation spreads through contact mostly while grazing
5	Mastitis	1	3	It leads to loss of productivity which occurs due to improper personal & udder hygiene and care, injuries, insect bites, fly bite, sitting in contaminated water, during grazing in the jungles or pasture land
6	Foot and mouth diseases	0	2	It is contagiuos viral disease which spread from one animal to another in grazing field.
7	Calf Pneumonia	0	2	Free ranching animal suffer more
8	Metabolic disorders			Occurs due to deficiency of mineral elements. Thus suitable feed / fodder and mixture of specific minerals needs to be fed
9	Mycotoxin in Feedstuffs & Aflatoxicosis	0	2	Mycotoxin causes serious problem leading to heavy mortality and morbidity
10	Walking stress	0	3	Animals walking longer distance and more time to receive sufficient feed/ fodder suffer from reduced growth & reproduction rate, increased inter-calving interval, reduced milk production and vulnerable to diseases
11	Tympany or bloat	0	2	Proper mix of feed and fodder is essential. It is difficult to ensure proper feed mix for freely grazing animals

(Severity incidence scale: 0 – very low/nil; 1 – slight / occasional; 2 – moderate; 3 – severe)

The total milk production in 2018 was 16.99 thousand liters with mean per day productivity of 1.38 L per animal. It showed that the animal productivity (milk) is very low in the islands probably due to poor and imbalanced nutrition, lack of green fodder mainly during dry period (January to March), infertility and prevalence of parasitic and gastrointestinal parasitic diseases in dairy cattle (Perumal 2018). Though majority of the farmers rear the animals in mixed farming system, lack of feed and fodder poses the major limitation in increasing

the productivity of the animals. This requires suitable modification of the existing farming system by proper allocation of resources for different enterprises. In the present study rice based cropping systems was modified by inclusion of short duration fodder crops like sorghum, cowpea, maize in integrated farming systems approach that increased the fodder availability especially during dry months. In the IFS, the average milk production per lactation was around 1750 L with per day productivity of 6.0 L which far exceeds the average productivity of the Islands. The resource recycling between the enterprises further enhances the productivity of the each component enterprises and the total farm productivity. The results revealed that on an average 48.5 % of total net income is accounted by dairy component alone and ensured income flow all through the year.

Table 5. Performance of dairy component under IFS and free ranching

Sl.No	Items	Rearing method	
		Dairy animals in IFS	Free ranching animals*
1	Average milk production per lactation (L/animal)	1750	500-800
2	Mean lactation period (days)	295	270-290
3	Mean daily milk production (L/day/animal)	6.0	1.85 - 2.75
4	No. of calving	2 in 3 years	1 to2 in 3 years
5	Mean annual production from dairy unit (L/year)	3250	1150
6	Mean gross return (Rs.) from dairy unit	2,61,570	80,500
7	Mean total cost (Rs)	1,26,480	45,250
8	Mean net return (Rs)	1,35,090	59,250
9	Employment generation (man days year^{-1})	195	110
10	Total cost of external purchase	54,750	15,000
11	Imputed value of family labour	53,625	30,250
12	Imputed value of recycled products	18,105	-
13	B:C ratio	2.07	1.78
14	Contribution to the total farm income	48.5 %	35-40%
15	Upscaling to 15,000 ha (milk production = 3250 /ha x 15000 ha) t per year	48750	-
	Potential milk production (Lakh litres per day)	1.33	-

* Based on Kundu *et al*., 2009; DES, 2018 (AN Administration) and personal interaction with two dairy farmers

Based on the above findings, it is postulated that by bringing 15,000 ha annual cropped area under IFS, potentially 1.33 lakh L of milk per day can be produced in the island. This could meet the projected demand of 43,254 t per annum milk (Kundu *et al.* 2006) required in 2031. Thus on farm production of feed and fodder in farming systems approach will not only meet the fodder requirement of milch animals but also has the potential to enhance the milk production and improve the per capita milk availability in the Islands in future.

Other than feed and fodder for milk production, waste management is very important task in livestock farming. In the IFS unit, nearly 10,360 kg of cow dung and 8790 L of urine & shed washing were produced. The waste water

emerging from the cattle shed was used for irrigating the fodder crop or used for fish production in ponds or in rice-fish system. The solid waste (cow dung) was used for composting of farm waste and helped in recycling of nutrients. In free ranching system of animal rearing, this valuable manure is lost.

Table 6: A glimpse of waste generation in dairy unit and its potential use under IFS

Item	Mean	Remarks
Cow dung (kg)	10,360	Used in compost preparation.
Urine & shed washings (L)	8,790	Used for irrigating vegetables and fodder cultivated in the beds of BBF system and also used for rice-fish system in the furrows.
Shed waste (kg)	3,620	Recycled into compost preparation

Conclusions

The shortage of feed and fodder is hampering the development of dairy units in the island though the demand is kept increasing. The shortage can be met from on-form production of green fodder, use of rice straw and crop residues produced in IFS units. Due to the fact that in these areas paddy straw is abundantly available from cultivating paddy, farmers can use rice straw as the main roughage source to their animals but supplement it with green fodder and concentrates. For further use during wet season the excess straw can be converted into hay /silage by suitable treatment. Most importantly, integration of fodder in the existing cropping pattern (intercropping in the coconut and areca nut) should be encouraged for improving fodder production. At the same time every animal needs to be supplemented with required concentrate feed (1.5 to 2.0 kg /day). The role of agro-forestry systems in augmenting the supply of green forage needs to be emphasized to farmers. Although forage based feeding systems help lower feed costs, the scope for such systems is limited in India because of the need to give priority to food crops.

The use of poor quality fodder or grasses leads to more energy loss as the animal utilizes more energy for grazing, mastication, digestion and other activities related to that feed or fodder. Therefore, the crossbred cows requires a suitable grazing/walking and feeding policy or strategy to prevent or minimise the deleterious effect stimulated by walking and dry season to the cows of Andaman and Nicobar Islands. And an ideal methodology needs to form for supplementation of suitable feed, fodder, electrolytes & antioxidants to minimise the stresses.

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