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Production and Profitability of Diversified Intensive Cropping System Suitable for North Western Zone of Tamil Nadu

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ABSTRACT

Background: Cropping system is an essential component of a farming system. Farmers use a variety of cropping systems based on their expertise, scientific validation is essential before recommending a certain cropping system for a specific area. The purpose of the study was to determine the yield and profitability of a diversified intensive cropping system with nutrient management strategies that are more productive and profitable than existing ones for Tamil Nadu's North Western Zone.

Methods: With four replications, the experiment was set up in a strip plot style. Five treatments were used, one of which included intensive diversified cropping systems *viz.,* C_1: Groundnut-chillies-greengram, C_2: Groundnut + redgram (6:1)-sorghum-blackgram, C_3: Maize + fodder cowpea (1:1) - sunflower-greengram, C_4: Bhendi + coriander (1:1) - tomato-blackgram, C_5: Brinjal + onion (1:2) - cowpea-sunnhemp were taken in main-plots and five nutrient management practices treatments were imposed in sub-plots, including farm yard manure at 12.5 t/ha and vermicompost at 2.5, 5 and 7.5 t/ha, as well as fertilisers at variable levels of 100, 75 and 50 per cent were imposed in sub-plots.

Result: Higher total system groundnut equivalent yield was recorded in Bhendi + coriander (1:1) - tomato - blackgram cropping system with respect to nutrient management it was recorded higher in farmyard manure @ 12.5 t/ha along with application of 100 per cent recommended dose of fertilizer. Higher B:C ratio and net return was recorded in Bhendi + coriander (1:1) - tomato - blackgram cropping system in terms of nutrient management it was recorded higher in farmyard manure @ 12.5 t/ha along with application of 100 per cent recommended dose of fertilizer.

Key words: Cropping system, Farmyard manure, System productivity, System profitability, Vermicompost.

INTRODUCTION

Cropping system is an essential component of a farming system (Tony *et al.,* 2020). It depicts a farm's cropping pattern and how it interacts with farm resources, other farm enterprises and available technologies to define its makeup. Despite the fact that farmers use a variety of cropping systems based on their expertise, scientific validation is essential before recommending a certain cropping system for a specific area (Mokidul *et al.,* 2017). A viable farming system with novel rewarding crops may introduce new opportunities and challenges while demonstrating the potential for increased land productivity through efficient resource management (Adarsh *et al.,* 2019). Cropping system study is based on a scientific approach that identifies a number of distinct categories (Biswas, 2015). To explain the enactment and consistency of the prevalent cropping patterns, the target area is first classified as an agroclimatic zone. Second, the characteristics, needs and resources available to farmers are conceptualised. Third, a scientific model is utilised to ensure that the desired cropping pattern is compatible with the farmer's resources and socioeconomic background. Fourth, the process must have a built-in mechanism for research and extension to collaborate and contribute to technology generation, validation and application. Farmers have expressed interest in growing hybrid crops in recent years, owing to its high commercial yield, uniform size, improved quality and better market price (Melinda *et al.,* 2018). The maximum genetic expression of potential yield is achieved only by fine-tuning the nutrition routine at several crucial stages of crop development (Sapkota *et al.,* 2021).

Nutrient management is anticipated to play a key role in increasing crop yield and ensuring a cropping system's overall food output (Yasodha and Chinnusamy, 2019). Among the organic manures, farmyard manure (FYM) is one of the most traditional sources, most readily accessible and extensively used by the farmers since time immemorial (Timsina, 2018). FYM is the decomposed material of cattle shed waste, dung, cattle urine and left over fodder and bedding material. It increases soil microbiological activities, plays crucial role in transformation, recycling and availability of nutrients to the crop (Jagadish, 2018). Vermicompost is an aerobically degraded organic matter, which would further

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be disintegrated by the enzymatic activity in the gut of earth worms and hence associated with enzymes of microbial population (Pathma and Sakthivel, 2012). It is an excellent, nutrient-rich organic fertilizer and soil conditioner. Addition of FYM and vermicompost with inorganic fertilizers improves organic matter content of soil and consequently water holding capacity of soil (Guriqbal *et al.,* 2012). Adoption of nutrient management strategies based on initial soil condition and component crop yield levels pave the way for the development of new cropping systems that are more productive and profitable than existing ones. Cropping systems were originally designed to increase agro-system productivity, however modern agriculture is more concerned with cropping systems environmental sustainability (Vukicevich *et al.,* 2016). In light of the aforementioned, the current research aimed to determine the yield and profitability of a diversified intensive cropping system appropriate for Tamil Nadu's North Western Zone.

Materials and Methods

Experiment location

An experiment was conducted in farmer field at Dharmapuri (latitudes N 11 47′ and 12 33′ and longitudes E 77 02′ and 78 40′ at an elevation of 457 m above Mean Sea Level (MSL), Tamil Nadu during *kharif, rabi* and summer seasons of 2017-18 and 2018-19. A uniformity trial on sorghum was undertaken during *rabi* 2016-17 to ensure uniform soil physico-chemical status in the entire field. The soil (0-15 cm layer) of the experimental site had a sandy clay loam in texture (Piper, 2019) with pH 7.8 (1:2.5 soil and water ratio), EC 0.4 ds/m (Conductivity bridge), organic carbon 0.4% (Mohammad and Hasan, 2016) low in available nitrogen with 263 kg/ha (Subbiah and Asija, 1956), medium in available phosphorous with 20.17 kg/ha (Olsen *et al.,* 1954) and potassium with 234 kg/ha (Stanford and English, 1949).

Experimental details

The experiment was set up in a strip plot pattern and it was repeated four times in fixed plots. Five treatments were used, one of which included intensive diversified cropping systems. *viz.,* C_1: Groundnut - chillies -greengram, C_2: Groundnut + redgram-sorghum-blackgram, C_3: Maize + fodder cowpea-sunflower-greengram, C_4: Bhendi + coriander (1:1)-tomato-blackgram, C_5: Brinjal + onion (1:2)-cowpea-sunnhemp were taken in main-plots and five nutrient management practises treatments were imposed in sub-plots *viz.,* N_1: Farm yard manure at 12.5 t/ha with 100% RDF, N_2: Vermicompost at 2.5 t/ha with 100% RDF, N_3: Vermicompost at 5 t/ha with 100% RDF, N_4: Vermicompost at 5 t/ha with 75% RDF and N_5: Vermicompost at 7.5 t/ha with 50% RDF.

The nutrient management practices were imposed on crops grown in the *kharif, rabi* and summer season crops but organic manures were applied in the *kharif* season only. Vermicompost, FYM and inorganic fertilisers were broadcast uniformly before crop sowing as per the treatment plan. Nitrogen, phosphorous and potassium were applied, through urea, single super phosphate and muriate of potash respectively. All intercultural operations were carried out in accordance with standard agronomic practises as detailed in the crop production guide.

Crop equivalent yield of cropping system was calculated by taking into account the yield of component crop multiplied with prevailing price of intercrop. Groundnut is the predominant crop of that region and all the cropping system was converted to the respective groundnut equivalent yield. Groundnut equivalent yield (GEY) was calculated based on the formula given below:

$$\text{GEY (kg/ha)} = \frac{\text{Yield of groundnut crop} \times \text{Price of groundnut} \quad \text{Yield of sequence crop} \times \text{Price of sequence crop}}{\text{Price of groundnut (Rs.kg)}}$$

Cost of cultivation and gross return for all the treatments were worked out on the basis of prevailing input cost and market price of the grain at the time of experimentation. The net income was calculated by deducting the cost of cultivation from the gross return. The benefit cost ratio (BCR) was worked out as dividing gross return by cost of cultivation. The data on various characters studied during the course of investigation were statistically analyzed as suggested by Gomez and Gomez (2010). Wherever the treatment differences were significant (F test), critical differences were worked out at five percent probability level and the values were furnished.

Results and Discussion

Productivity of nutrient intensive cropping system (Table 1)

Kharif groundnut equivalent yield

Productivity potential of the different cropping systems was evaluated in terms of Groundnut Equivalent Yield (GEY). Among the *kharif* season crops, higher GEY of 9.25 t/ha was recorded in brinjal intercropped with onion (1:2 ratio) which was followed by bhendi intercropped with coriander (1:1 ratio) cropping system with 5.99 t/ha because of higher productivity and higher prices fetched by brinjal along with onion led to uphold higher equivalent yield when compared to bhendi crop. Lower GEY was recorded in groundnut sole cropping system as productivity in sole cropping system was lesser when compared to intercropping system. Among different nutrient management practices, higher GEY of 4.88 t/ha was recorded with the application of vermicompost at 5t/ha along with 100 per cent NPK fertilizer. These might be due to vermicompost which might have improved the soil fertility where all the appropriate nutrients are in readily available forms to the plants and have narrow C:N ratio (below 20:1) than FYM (Vasanthi and Kumaraswamy, 2000). Lower GEY recorded in vermicompost at 7.5 t/ha along with 50 per cent NPK fertilizer. Even though, we are applying vermicompost at a higher rate but the reduction of fertilizer

Table 1: Productivity of intensive cropping system influenced by nutrient management practices (Pooled data of 2017-18 and 2018-19).

Treatments	*Kharif* GEY (t/ha)	*Rabi* GEY (t/ha)	Summer GEY (t/ha)	Total system GEY (t/ha)
Cropping system				
M_1: Groundnut - chillies - greengram	2.17	2.13	1.01	5.31
M_2: Groundnut + redgram (6:1) - sorghum - blackgram	2.77	1.91	0.92	5.59
M_3: Maize + fodder cowpea (1:1) - sunflower - greengram	2.13	1.75	1.09	4.97
M_4: Bhendi + coriander (1:1) - tomato - blackgram	5.99	6.85	0.87	13.71
M_5: Brinjal + onion (1:2) - cowpea - sunnhemp	9.25	1.07	-	10.31
S.Ed. ±	0.04	0.03	0.01	0.09
C. D. at 5%	0.11	0.08	0.02	0.21
Nutrient management				
S_1: FYM at 12.5 t/ha + 100% RDF	4.66	3.20	1.10	8.85
S_2: VC at 2.5 t/ha + 100% RDF	4.55	2.86	0.99	8.30
S_3: VC at 5 t/ha + 100% RDF	4.88	2.94	1.06	8.77
S_4: VC at 5 t/ha + 75% RDF	4.18	2.60	0.88	7.58
S_5: VC at 7.5 t/ha + 50% RDF	4.03	2.11	0.84	6.90
S.Ed. ±	0.06	0.07	0.01	0.10
C. D. at 5%	0.12	0.13	0.02	0.20

dose to 50 per cent led to accomplish lower GEY (Kannan *et al.,* 2005).

Rabi groundnut equivalent yield

With reference to *rabi* season crops, higher GEY was registered in tomato based cropping system followed by chillies cropping system. Tomato is a highly productive vegetable crop as it was required in our daily diet and farmers can get the daily income which would be another suitable crop intensification alternative, besides enhancing farm productivity and profitability. Cowpea recorded lower GEY when compared to other system eventhough the price was high but the productivity of pulse crop was low when compared to other crops. Among different nutrient management practices, higher groundnut equivalent yield was recorded in 100 per cent NPK fertilizer. This might be due to the residual effect of INM (farm yard manure at 12.5 t/ha + 100 per cent RDF) practice during *kharif* season along with 100 per cent NPK fertilizer in current *rabi* season led to accumulation of more amount of available nutrient that creates good soil conditions for the crop growth. This results are in conformity with the findings of Antil and Singh (2007) who had earlier observed better growth, yield attributes and yield when residue of farm yard manure was combined with NPK. Lower groundnut yield was registered in 50 per cent NPK fertilizer because of reduction of fertilizer dose from 100 per cent NPK to 50 per cent NPK as the supply of nutrients might not have been in adequate amount for proper plant growth.

Summer groundnut equivalent yield

Short duration summer legume crop like green gram and black gram had greater potential in enhancing crop intensification and thus, harnessing better system productivity and profitability (Sharma and Sharma, 2005). Inclusion of N fixing legume crop and its residue incorporation after harvesting pods are added advantage of N-fixing for resilience soil fertility (Pooniya *et al.,* 2012). Higher groundnut equivalent yield was recorded in green gram crop in both the seasons because the productivity of greengram was slightly higher when compared to blackgram. With regard to different nutrient management practices, during summer season, higher groundnut equivalent yield was recorded in 100 per cent NPK fertilizer when compared to 75 per cent and 50 per cent NPK fertilizer because nutrient requirement of the crop was more in 75 per cent and 50 per cent NPK fertilizer when compared to 100 per cent that is the reason for a reduction in yield of 15 per cent in 75 per cent NPK fertilizer and 20 per cent in 50 per cent NPK fertilizer when compared to 100 per cent NPK fertilizer, during both the years. Kushwaha *et al.* (2018) found that application of 100 per cent RDF showing an increase of grain yield in sorghum by 15 per cent and dry fodder yield by 11 per cent over 75 per cent and 50 per cent RDF.

Total system equivalent yield

In the cropping systems, crops involved are of different nature, since an estimate of yield in terms of “total system equivalent yield” would be more appropriate criterion for evaluating the yield potential in the cropping sequences. Equivalent yield provides abundant scope for prescribing integrated nutrient management package for the cropping system as a whole considering the efficient and economic fertilizer use. Among the diversified cropping systems, higher GEY was registered in bhendi intercropped with coriander (1:1 ratio) - tomato - blackgram cropping system. Higher productivity of bhendi and tomato, inclusion of leafy coriander as an intensive cropping system along with inclusion of high value legume pulse during summer season

Table 2: Profitability of intensive cropping system influenced by nutrient management practices (Pooled data of 2017-18 and 2018-19).

Treatment	Total cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
M_1: Groundnut - chillies - greengram	169318	310667	141350	1.87
M_2: Groundnut + redgram (6:1) - sorghum - blackgram	141917	321316	179400	2.33
M_3: Maize + fodder cowpea (1:1) - sunflower - greengram	152560	299184	146624	2.00
M_4: Bhendi + coriander (1:1)- tomato - blackgram	186185	754483	568298	4.14
M_5: Brinjal + onion (1:2) - cowpea - sunnhemp	157091	587551	430460	3.79
S_1: FYM at 12.5 t/ha + 100% RDF	134597	491286	356690	3.56
S_2: VC at 2.5 t/ha + 100% RDF	145962	463733	317772	3.13
S_3: VC at 5 t/ha + 100% RDF	170962	481107	310146	2.76
S_4: VC at 5 t/ha + 75% RDF	167171	434830	267660	2.57
S_5: VC at 7.5 t/ha + 50% RDF	188380	402245	213865	2.12

and higher price fetched by vegetable during both the seasons led to record higher groundnut equivalent yield. This results are in agreement with the findings of Pooniya *et al.* (2017) where cropping systems imbedded with two vegetable crops *i.e.,* cowpea - potato - mungbean produced significantly higher mungbean yield than those having single vegetable crop in the sequence. Lower groundnut equivalent yield was recorded in groundnut based cropping system. This clearly indicates intensive based cropping system shows better performance when compared to existing system. Higher GEY was recorded in farmyard manure at 12.5 t/ha along with 100 per cent NPK fertilizer. Crop growth depends on nutrients so both macro and micro nutrients are essential for plant growth. A larger portion of nitrogen is made available as and when the FYM decomposes and balanced nutrition is made available to the plants when it was combined with 100 per cent NPK fertilizer. The yield reduction in the range from 13.50 per cent in 75 per cent NPK fertilizer, 23.50 per cent in 50 per cent NPK fertilizer when compared to 100 per cent NPK fertilizer.

Profitability of nutrient intensive cropping system (Table 2)

Among the different cropping systems, bhendi intercropped with coriander - tomato - blackgram cropping system had higher total cost of cultivation during both the years. The inclusion of two vegetable crops in the cropping system requires adequate care in terms of pesticide application, fruit and pod picking, staking for tomato crop that will make cost of cultivation to be higher. Higher gross return, net return and B:C ratio were recorded in bhendi intercropped with coriander - tomato - blackgram cropping system. Inclusion of two high value and high productive vegetable crop in this system along with addition of component crop and blackgram as summer season legume crop with higher market price for the both base and component crops in the these systems makes to attain higher B:C ratio. With respect to nutrient management practices, application of organic manure *i.e.,* farmyard manure at 12.5 t/ha during *kharif* season alone along with 100 per cent NPK fertilizer applied during all the three seasons during *kharif, rabi* and summer season recorded higher gross return, net return and B:C ratio. As the price of farmyard manure was comparatively low when compared to vermicompost and also it release nutrients gradually as per crop requirements along with recommended fertilizer leads to maintain high economic status.

CONCLUSION

Bhendi intercropped with coriander - tomato - blackgram cropping system along with application of farm yard manure at 12.5 t/ha with 100 per cent NPK fertilizer is a viable option in irrigated upland ecosystem of North Western Zone of Tamil Nadu.

Conflict of interest

All authors declare that they have no conflict of interest.

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