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Training Needs of Agricultural Extension Personnel in Meghalaya

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ABSTRACT

The changing scenario in agriculture, economy and communication has also increased the need for improving the skills of extension personnel. The first step in improving the skills of extension personnel would be to assess their training needs. The study was conducted in the year 2011-12. The present study was conducted in the Department of Agriculture and the three districts of Meghalaya viz., Ri Bhoi, Jaintia Hills and West Garo Hills were purposively selected for the study. The respondents were the Agricultural Demonstrators and the Horticultural Demonstrators and the sample size was 70. The important training need areas identified in order of importance are Soil Science, Entomology, Agronomy, Plant Pathology, Nematology and Horticulture. Correlation analysis has shown that age, service length, job performance and training exposure had a negative and significant correlation with training needs. Thus, variables like age, service length, job performance and training exposure could be considered while conducting training as these variables had significant correlation with the training needs of the respondents. As the training needs of extension personnel changed over time, training needs assessment should also be done on a regular basis and the important areas in which the extension personnel needs training should be considered while planning training for the extension personnel. Thus, appropriate measures should be taken by the department and other training institutions in addressing their grievances.

Keywords: Training need, Extension personnel, Transfer of technology, Training important score

INTRODUCTION

Agriculture is an important sector in the economy of India, as it contributes to 14.5 percent of national Gross Domestic Product (Ministry of External Affairs, GoI 2011). With the increase in population, the pressure on agriculture production is also increasing day by day. This calls for a greater co-ordination between research and extension. Hence, the need for strengthening the extension personnel through effective training programmes has become an integral part of the agricultural development strategy. In absence of training need assessment, the training conducted has not been able to meet the expectations of extension personnel. The training needs of extension personnel also changes from time to time due to rapid changes in technology and information delivery systems. Thus, this call for training needs assessment of extension personnel before conducting a training programme.

Training needs for extension personnel can be defined in terms of gap between job requirement and job performance (Mishra 1990). The training needs of agricultural school masters can be worked out with the help of Training Need Quotient developed by Sidhu (1973).

The Department of Agriculture, Meghalaya was created in the year 1882 under the Government of Assam. It was set up with the objective of implementing the various schemes given by the state and central government for the development of the farmers of the state. Extension and Training is one of the twelve developmental activities of the Department of Agriculture, Meghalaya. Thus, the department needs skilled and well trained extension personnel to implement the various agricultural programmes. In this background the present study was undertaken with the following objectives:

1. To identify the perceived training needs of selected extension personnel

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2. To analyze the relationship of personal and organizational variables with training needs

MATERIALS AND METHODS

The study was conducted in Meghalaya in the year 2011 - 2012. There are seven districts *viz*., East Khasi Hills, West Khasi Hills, Jaintia Hills, Ri Bhoi, East Garo Hills, West Garo Hills and South Garo Hills in the state. The District Agriculture and Horticulture Office of the three districts of Ri Bhoi, Jaintia Hills and West Garo Hills were purposively selected for the study as they have the highest number of Agricultural Demonstrators. The respondents selected for the study were the agricultural and horticultural demonstrators who are working under the District Agricultural/ Horticultural offices of the three districts. Out of a total of 72 respondents, 70 responses were received. Hence, the total number of respondents for the study was 70. Data collection was done by an interview schedule. The training needs of agricultural/ horticultural demonstrators were worked out with the help of Training Need Quotient (TNQ) developed by Sidhu (1973). The formula for calculating TNQ is as follow:

$$TNQ = \frac{OTig}{MTS}$$

Where,

OTig = Sum of observed training scores of the items of the ith respondent

MTS = Sum of the maximum training scores attributed to the items rated by ith respondents

TNQ = Training Need Quotient

The training importance score (TIS) of each item was calculated with the following formula:

$$TIS = \frac{Cumulative\ training\ importance\ score\ over\ all\ the\ respondents}{Number\ of\ respondent}$$

Further the training importance score of an area (ATIS) was computed out with the following formula:

$$ATIS = \frac{Sum\ of\ training\ importance\ score\ of\ all\ items\ in\ an\ area}{Number\ of\ items\ included\ in\ the\ training\ area}$$

To find out the relationship between the dependent and independent variables, Spearman's Rank co-efficient of correlation was used.

$$r = 1 - \frac{6\sum d^2}{n\ (n^2 - 1)}$$

Where,

r = coefficient of correlation

d = differences of ranks between paired samples

n = no. of pairs of observations

'The perceived training needs of agricultural/ horticultural demonstrators' was the dependent variable of the study. There were ten independent variables selected for the study. The variables and their measurement is given in Table 1.

Table 1: Variables and their measurement

Sl. No.	Variable	Measurement
	Dependent variable	
1.	Perceived training needs (Training need is a matter of requiring action to be taken in the areas of knowledge, skill and attitude so as to reduce obsolescence among people and organization) (Fowler 1924).	Training Need Quotient (Sidhu 1973) Scoring Low 50 - 75 Medium 76 - 90 High 91 - 100
	Independent Variable	
1.	Age (It refers to the chronological age of a respondent at the time the interview was conducted, expressed in years rounded off.)	Chronological age in completed years Scoring Low Upto 32 years Medium 33 – 44 years High 45 years above
2.	Gender (It is the biological difference between male and female.)	Scoring Male 1 Female 2
3.	Family size (Family size was operationalized as the total number of members residing together in the family at the time of data collection.)	Scoring Low Upto 3 Medium 4 - 6 High 7 above
4.	Education level (It is operationalized as the highest level of formal education successfully completed by extension personnel at the time of data collection.)	Scoring Class X 1 Class XII 2 B.A/B.Sc. 3

Contd...

Sl. No.	Variable	Measurement
5.	Family background (It refers to the respondent's place of birth and the place where a respondent was brought up before he joins the service.)	Scoring Urban 1 Semi urban 2 Rural 3
6.	Training exposure (It refers to the duration of a professional training undergone by a respondent in the last one year.)	Training Score = (Training Duration x Training Number x Training Location) Scoring Low Upto 1 Medium 1.01 – 7.66 High 7.67 above
7.	Mass media exposure (It can be operationalised as the frequency of using different mass media *viz*., radio, TV, farm literature, newspaper etc. by a respondent to gain or improved knowledge on improved farm practices.)	Frequency of using mass media Scoring Daily 4 Weekly 3 Monthly 2 Occasionally 1 Never 0
8.	Service length (It is the service tenure measured in years rounded off from the date of joining in the department to the date of data collection.)	Scoring in completed years Scoring Low Upto 6 years Medium 7 – 20 years High 21 years above
9.	Job performance (The job performance of extension personnel was operationalized as, "the degree to which an extension personnel accomplishes the tasks assigned to him in terms of quality and quantity" (Reddy 1990).	Interview Schedule Scoring Low Upto 32.54 Medium 32.55– 78.72 High 78.73 above
10.	Organizational climate (Organizational climate refers to the perception of an extension worker about his work place, facilities, co-workers, etc. it was measured by the scale constructed by Kolb et al. (1974).	Scoring Low Upto 6.05 Medium 6.06 – 12.83 High 12.84 above

RESULTS AND DISCUSSION

Table 2: Profile of the respondents

(n = 70)

Sl. No.	Independent variable	Category	Frequency (%)	Mean	SD
1.	Age	Young (upto 32 years)	11.00 (15.71)	30.56	2.19
		Medium (33 - 44 years)	47.00 (67.15)	40.19	2.52
		Old (45 years and above)	12.00 (17.14)	48.25	2.60
	Overall			38.90	5.76
2.	Gender	Male	70.00 (100.00)	-	-
		Female	0.00 0.00	-	-
3.	Family size	Small (upto 3)	7.00 (10.00)	2.83	0.79
		Medium (4 – 6)	43.00 (61.43)	5.42	1.10
		Big (7 and above)	20.00 (28.57)	8.22	0.44
	Overall			5.56	1.60
4.	Educational level	Class X	25.00 (35.71)	-	-
		Class XII	28.00 (40.00)	-	-
		B.A/B.Sc.	17.00 (24.29)	-	-
	Overall			1.88	0.77
5.	Family background	Urban	17.00 (24.29)	-	-
		Semi-urban	25.00 (35.71)	-	-
		Rural	28.00 (40.00)	-	-
	Overall			2.16	0.79

The lower percentage of younger extension personnel in comparison to the older ones is due to the fact that the number of extension personnel recruited in the last five years is only nine. This is in conformity with the finding of Mohan (2000) that majority (51.21%) of the extension personnel were in the age group of 35-50 years while 12.68 percent were above 50 years of age. Cent percent of the respondents were male. This is due to the fact that male candidates are preferred for the post of demonstrator, as their job is not confined to the

office only. Also, there were no women candidates applying for the post as men candidates dominated the department. The finding is in agreement with Thanh and Singh (2007) who reported that most of the Indian extension personnel at district and block level were males; 100 percent for district level and 97 percent for block level.

Most of the demonstrators (88.57%) were already married and also 35.71 percent of them live in joint family. Thus, the number of members in a household is more. Oladele and Mabe (2010) reported that more than half (54%) of the extension officers had between 4 to 6 persons as household size. Most of the people who applied for the job did not have the opportunities to go for further studies. Thus, majority of the respondents were only Class X or Class XII passed. However, all of the respondents attended a two years pre-service training programme before joining the job. Rao (1985) and Patel et al. (1994) reported that majority of the extension personnel possessed Secondary School Leaving Certificate qualification with gram sevak training or studied upto higher secondary level. As people from rural and semi-urban background give more preference for jobs in the agriculture sector, thus majority of the respondents belonged to rural and semi-rural background of family. The finding is in conformity with the study conducted by Belay and Abebaw (2004) that 72.20 percent of the respondents are from rural background and 27.80 percent are from urban background respectively.

Apart from the 2 years pre-service training that the demonstrators underwent at Basic Agricultural Training Centre, Shillong, the in-service training programmes organized by the department are not attended by all the extension personal as most of them need to attend to their family or other personal commitments and also due to lack of interest of the demonstrators. Thus, their training exposure is less. The finding is contradictory to Patel et al. (1994) who reported that majority (93 percent) of Rural Agricultural Extension Officers were professionally untrained. Medium exposure to mass media revealed that majority of the respondents have access to radio, television, newspaper, journals, magazines etc. but due to time constraint and lack of interest they are not utilizing the sources to the fullest extent. Similar finding was reported by Mohan (2000) where majority of the extension personnel had medium level of mass media exposure. As majority of the respondents were in the medium category of age group, they also belonged to the medium category of service length. The finding is in conformity with the finding of Alibaygi and Zarafshani (2008) that 78.07 percent of the respondents had more than 10 years of work experience.

The high level of job performance is because the older respondents already had more experience than the younger respondents, so their job performance is high. The low level of job performance is due to the unavailability of facilities and infrastructure in remote areas. Thippeswamaiah (1991) found that 60.80 percent of subject matter specialists belonged to medium job performance category followed by 21.60 percent in low and 17.60 percent in the high performance category. Majority of the respondents indicated the presence of a pleasant environment with regard to the rules, procedures, policies and practices, decision making, problem solving, communication, rewarding good work, well defined goals, friendliness and leadership quality among the staff of the Department of Agriculture, Meghalaya. The results are similar to the findings of Halakatti and Sundaraswamy (1997) that majority (68%) of the Agricultural Assistant belonged to medium level of organizational climate perception followed by 22 and 10 percent of them who belonged to low and high categories respectively.

It is observed from the Table 3 that majority of the respondents has low and medium level of training needs. This is due to the fact that all of the respondents already attended a 2 years pre-service training at Basic Agricultural Training Centre, Shillong before joining the post. Also, most of the respondents have already been working for more than 7 years, so they already have some experience in their job, thus they felt that they need less training.

Table 3: Distribution of respondents according to their levels of training need (n=70)

TNQ Categories	Frequency (%)	Mean	SD
Low (50-75)	34.00 (48.57)	69.06	6.43
Medium (76-90)	34.00 (48.57)	81.80	3.97
High (91-100)	2.00 (2.86)	93.17	0.23
	Overall	75.94	8.74

Note: Figures in parentheses indicates percentages to total

It is seen from the Table 4 that out of 155 items, the extension personnel rated 45 items (29.03%) as most important, 82 items (52.90%) were rated as important and 28 items (18.07%) were found to be less important. These items were further grouped into their separate areas/discipline to find out the areas which need more training.

Table 4: Distribution of items on Training Importance Score categories (n=155)

TNQ Categories	Frequency (%)	Mean	SD
Less important (upto 0.99)	28.00 (18.07)	0.75	0.18
Important (1-1.49)	82.00 (52.90)	1.33	0.11
Most important (1.50 and above)	45.00 (29.03)	1.61	0.08
Overall		1.31	0.18

Note: Figures in parentheses indicates percentages to total

The different areas when arranged in descending order of their ranks are Soil Science, Entomology, Agronomy, Plant Pathology, Nematology, Horticulture, Plantation Crops, Agricultural Extension, Agricultural Engineering, Agricultural Economics, Other areas, Crop Demonstration, Training planning and evaluation, Plant Breeding and Reporting. The rank of different areas based on Area Training Important Score (ATIS) is given in the Table 5.

Table 5: Area-wise distribution of training needs on the basis of ATIS (n = 70)

Sl. No.	Area	ATIS	RANK
1.	Soil Science	1.52	I
2.	Entomology	1.51	II
3.	Agronomy	1.51	III
4.	Plant Pathology	1.48	IV
5.	Nematology	1.45	V
6.	Horticulture	1.40	VI
7.	Plantation crops	1.38	VII
8.	Agricultural Extension	1.37	VIII
9.	Agricultural Engineering	1.33	IX
10.	Agricultural Economics	1.26	X
11.	Other areas (IPR, Climate change, Social Forestry)	1.21	XI
12.	Training planning and evaluation	1.10	XII
13.	Crop demonstration	0.99	XIII
14.	Plant Breeding	0.90	XIV
15.	Preparation of reports	0.67	XV

Soil Science is ranked as the first most needed area of training. This is due to the fact that the trainings in this area are rarely conducted. Also, with the introduction of Soil Testing Laboratory, many progressive farmers are going for soil testing before planting their crops. Thus, the extension personnel need to improve their knowledge and skills regarding the proper measures to be taken in order to properly manage the soil. The attack of pest and rodents in the past years has made the farmers realize about the importance of proper management process which would help in reducing the losses in agricultural produce. This creates more training needs on the part of the demonstrator in the area of Entomology. In the area of Agronomy, the growing of HYV variety of crops, losses incurred due to weeds has made the farmers realize the importance of proper package of practice. The demonstrators still need the help of higher officials in identifying the symptoms in case of attack from pests, diseases or nematodes. Thus, the demonstrators need training in the areas of Plant Pathology and Nematology as well.

Regarding Horticulture much stress has been given by the state department. The introduction of high value low volume crops like strawberry, flowers like rose, lilium, anthurium, carnation, birds of paradise, and vegetables like broccoli and coloured capsicum increases the need for training. As more and more farmers are becoming interested in the cultivation of plantation crops, there is also a need for training demonstrators in the field of plantation crops. Even though demonstrators have proper knowledge regarding the extension programmes, they still need training in putting the knowledge and information they received into practice. The farming system in the state is not yet fully mechanized but farmers are adopting implements which are manually operated and which they can afford. Thus, the training that the demonstrators need is in the use of small implements and tools. The growth of farmers and farm women has increased the need for training in the post harvest technology and simple storage and packaging which could help in extending the shelf life of crops and help them fetch a better price. The demonstrators also need training in updating themselves about the recent programmes and opportunities that the government is giving to the farmers like crop insurance scheme, kisan credit card, etc.

The demonstrators also need training in aspects related to IPR and Social forestry programmes as well as these areas are very new to them. The demonstrators are already acquainted with crop demonstration. Thus, their training needs are not high in this regard. When it comes to the process of conducting training, demonstrators need to improve their skills in planning and evaluation. Plant Breeding activities are not performed by the demonstrators. Thus, not much training is needed. Demonstrators are well acquainted with 'Reporting' as they are involved in preparation of reports and muster roll bills every quarter.

The findings are in conformity with Kalita (1992) who reported that some of the most important training need areas for village level extension workers are Entomology, Plant Pathology, Soil Science and Horticulture in order of importance.

Table 6 reveals a significant and negative correlation between training need and age, training exposure, service length, and job performance which indicates that with the increase in these variables, the training needs will decrease and vice-versa.

Table 6: Correlation co-efficient of selected independent variables with training needs of extension personnel (n=70)

Sl. No.	Variables	Training needs	
		r-value	p-value
1.	Age	-0.40	0.0005**
2.	Family size	0.07	0.5495
3.	Education	0.22	0.0625
4.	Family background	0.02	0.8102
5.	Training exposure	-0.29	0.0128*
6.	Mass media exposure	-0.16	0.1656
7.	Service length	-0.38	0.0009**
8.	Job performance	-0.43	0.0002**
9.	Organizational climate	-0.03	0.8032

Note: ** Significant at 0.01 level of probability
* Significant at 0.05 level of probability

Thus, the extension personnel who are younger in age, having lesser exposure to training, whose service length is not long, and who have lower job performance levels, have higher needs for training. The younger extension personnel have lesser experience thus they are more enthusiastic about their job unlike the older extension personnel who had been working for many years. Thus, the training needs of younger extension personnel are high. Extension personnel with lower exposure to training are lacking behind in skills and knowledge in comparison to the one who attended trainings regularly. With regards to service length, extension personnel who just started; need to learn many things about their job, thus they have higher training needs. Job performance is also negatively related to training needs, as extension personnel who could not perform their job effectively and efficiently need more training than the one who could perform their job well.

These findings are similar to the findings of the study conducted by Kalita (1992) that training needs of village level workers has a significant correlation with age, and training exposure. Also, Sharma (1995) reported that characteristics namely, age, service experience had significant correlation with the extent of training needs. The finding is also in conformity with the finding of Rajanna et al. (2009) that job performance of Agricultural Assistants had a significant relationship with their training needs. In a research conducted in Manipur, it was found that age and service experience of the respondents are significantly and negatively correlated with the training needs (Singh et al. 2011).

SUMMARY

The study was conducted at the District Agriculture/Horticulture Office in the three districts of Ri Bhoi, Jaintia Hills and West Garo Hills under the Department of Agriculture. The agricultural and horticultural demonstrators were the respondents and they were selected by purposive sampling. A total of 70 demonstrators were selected for the study.

In the present study 'perceived training need' was the dependent variable. There were ten independent variables selected for the study *viz*. age, gender, family size, educational level, family background, training exposure, mass media exposure, service length, job performance and organizational climate. The data were collected through interview schedule. Frequency, percentage, means, standard deviation, Spearman's Rank Correlation was used in analysis and data interpretation.

From the frequency and percentage analysis of the personal and organizational variables of the extension personnel, it was found that all of the respondents were male (100%) in between 33 -44 years of age (67.14%) and Class XII passed (61.43%). They had a family size of 4 -6 (67.43%) and came from a rural background (40%). They had medium exposure to training (54.29%) and mass media (68.57%). Their service length ranged from 7 – 20 years (71.43%), they had medium level of job performance (60%) and they perceived a favourable organizational climate towards their department (61.43%).

An equal percentage of extension personnel had low (48.57%) and medium (48.57%) level of training needs. Items wise, 52.90 percent of the items were rated as important. The important training need areas in order of importance are Soil Science, Entomology, Agronomy, Plant Pathology, Nematology, Horticulture, Plantation Crops, Agricultural Extension, Agricultural Engineering, Agricultural Economics, areas related to IPR, Climate, Crop demonstration, Training planning and evaluation and Plant Breeding.

Spearman's Rank Correlation revealed that the variables age (r = -0.40), training exposure (r = -0.29), service length (r = -0.38) and job performance (r = -0.43) had negative and significant correlation with training needs.

CONCLUSIONS

The findings regarding the training needs of the extension personnel revealed that majority of the extension personnel had low and medium training needs. Thus, necessary steps should be taken to identify the unfelt needs of the demonstrators and strengthen their knowledge, skills and attitudes required for performing their job efficiently. The findings of the study revealed that the six areas with highest ATIS are Soil Science, Entomology, Agronomy, Plant Pathology, Nematology and Horticulture. Thus, the study stresses the need for organizing trainings in these six areas. So, the Department of Agriculture as well as the concerned training organizations needs to organize training programmes covering these areas according to their importance. The variables age, service length, job performance and training exposure should be considered while conducting training as those variables had significant correlation with the training needs of the respondents. Thus, while conducting training, younger age extension personnel should be preferred. Also, preference should be given to extension personnel with lesser service length. Extension personnel with low exposure to training should be given priority and job performance should be properly monitored by the higher officials and those with low performance level should be given priority while conducting training. As the training needs of extension personnel changes over time, training needs assessment should also be done on a regular basis and the important areas in which the extension personnel needs training should be considered while planning training for the extension personnel by the Department and other training institutions for the betterment of the extension personnel and the Department as well.

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REFERENCES

Alibaygi A, Zarafshani K (2008).Training needs of Iranian extension agents about sustainability: The use of Borich's need assessment model. African Journal of Agricultural Research 3 (10):681-687 http://www.academicjournals.org/AJAR, Accessed 23 November 2011

Belay K, Abebaw D (2004). Challenges facing agricultural extension agents: A case study from South Western Ethiopia. African Development Bank, Blackwell Publishing Limited Oxford, UK

Halakatti SV, Sundaraswamy B (1998). Achievement motivation of agricultural assistants and associated factors – a critical analysis. Karnataka J. Agril. Sci. 9(4): 6780-

674 http://etd.uasd.edu/ft/th9439.pdf, Accessed 15 November 2011

Kolb DA, Rubin IM, McIntyre JM (1974). Organizational Psychology. 2nd edn. Prentice Hall Inc, New Jersey

Kalita HK (1992). A study on training needs of village level extension workers of Assam. M.Sc. Thesis, Assam Agricultural University, Jorhat, India

Mohan B (2000). A study on job performance and job satisfaction of Assistant Agricultural Officers in Northern districts of Karnataka. M.Sc.(Agri.) Thesis, University of Agricultural Science, Dharwad (India). http://etd.uasd.edu/ft/th9439.pdf, Accessed 10 October 2011

Ministry of External Affairs, Government of India (2011). From http://www.indianbusiness.nic.in/economy/agriculture.htm. Accessed 18 January 2012

Mishra DC (1990). New Directions In Extension Training. Directorate of Extension, Ministry of Agriculture. New Delhi

Oladele OI, Mabe LK (2010). Socio-economic Determinants of Job Satisfaction among Extension Officers in North West Province South Africa. Life Science Journal 7(3): 99-104. http://www.sciencepub.net., Accessed 7 January 2012

Patel MM, Dubey MC, Sharma HO (1994). Performance of Rural Agricultural Extension Officers. Maharashtra Journal of Extension Education 8: 31-33

Rajanna N, Vijayalaxmi KG, Varadaraju GM (2009). Training needs of field extension workers on plant protection and allied activities: a study in Bangalore rural district. Mysore Journal of Agricultural Sciences 43(4): 787-791. http://www.uasbangalore.edu.in/asp/periodicals.asp, Accessed 27 November 2011

Rao R (1985). Task and time management by Assistant Agricultural Officers working under AEP in Karnataka. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, India

Sharma S (1995). A study on training needs of village extension workers of Upper Brahmaputra Valley Zone of Assam on horticultural crops cultivation technology. M.Sc. (Agri.) Thesis, Assam Agricultural University, Jorhat, India

Sidhu BS (1973). Training needs of agricultural masters in high school of Punjab. Summaries of extension research by post graduate students 5. Department of Extension Education, PAU, Ludhiana

Singh MK, Ram D, Kh S, Prasad A (2011). Correlates training needs assessment of assistant agricultural officers of Manipur. Indian Research Journal of Extension Education 11(1): 120-121

Thanh NC, Singh B (2007). Problems faced by extension personnel – some comparisons between Vietnam and India. Omairice 15: 164-173

Thippeswamaiah JM (1991). A study on the job performance and job satisfaction of Subject Matter Specialists working under NAEP, Karnataka. M.Sc. (Agri.) Thesis, University of Agricultural Science, Dharwad, India

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Benefit-Cost Ratio Analysis of Pineapple Orchard in Meghalaya

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ABSTRACT

The present study was conducted in Ri-Bhoi district of Meghalaya. Pineapple cultivation was found to be economically feasible in the state. The category wise economic analysis of pineapple implies economies of scale. Cultivation of pineapple in the region is undoubtedly a very perspective venture with the region being an agrarian society with an average of 80 per cent tribal population, this will result in a breakthrough of social empowerment of the tribal people of the North East states of India. Thus, economic benefits of pineapple should be realised to the farmers to enhance the production and productivity of pineapple. Pineapple production in the region is organic by default, hence organic pineapple certification agencies should be initiated in the state. A suitable scientific package of practices of pineapple in local dialect should be prepared for the pineapple growers.

Keywords*:* B-C ratio, Pineapple, Orchard, Meghalaya

INTRODUCTION

India ranks third in area and sixth in pineapple production in the world with an area of 91.90 thousand ha and production of 13.86 lakhs million ton during 2010 (NHB 2010). The NEH region produces more than 40 per cent of the total pineapple of the country and almost 90-95 per cent of the produce is organic (Chishi 2010). The total area in Meghalaya under fruits is 27.74 thousand ha in which pineapple contributes 38 per cent area (10.5 thousand ha) (Anonymous 2010). Area under pineapple production was observed to increase in Meghalaya, but the productivity is still low. The farmers are always interested in maximizing their profit and not merely production. Therefore, there is a need to carry out a benefit cost and returns analysis is carried out systematically and this study is an effort in that direction.

MATERIALS AND METHODS

The present study was conducted in four villages viz., Thad, Shagbangla, Nongkhrah and Pham-myrloi of Ri-Bhoi district of Meghalaya during 2011-12. The primary data were collected from the respondents through personal interview method on pre-tested well structured questionnaire. Total 60 pineapple growers were selected randomly and categorised into three categories *viz,* small (up to 1.99 ha), medium (2 to 3.99 ha) and large (4 ha and above). For analysis of data, budgeting techniques and cost concepts (establishment cost, fixed cost, variable cost and total cost)and economic efficiency measures viz.,Benefit-Cost Ratio, Net Present Value, Payback period and Break–Even point were used.

Benefit-Cost Ratio

This criterion indicates the rate of return per rupee invested in pineapple enterprise. It was worked out by dividing the sum of discounted net cash flow by the establishment cost at 9 per cent rate of interest (Reddy and Ram 1996).

$$\text{BC Ratio} = \frac{\text{Present Worth of Gross returns}}{\text{Present worth of costs}}$$

Payback period

Payback period represents the length of time required for the stream of cash proceeds produced by the investment to be equal to the original cash outlay i.e., the time required for project to pay for itself. In the present study payback period of

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pineapple after fruit bearing was calculated by using the following formula.

$$PBP = \frac{\text{Discounted total cost}}{\text{Annual increase in income (Mean discounted benefit)}}$$

Break –Even point

Break- even point is the point at which the two curves, total cost curve and total revenue curve intersect which indicate the level of production at which the producer neither loss money nor makes a profit. It was calculated by using the following formulae

$$BEP = \frac{TFC}{(ASP-AVC)}$$

Where,

TFC= Total fixed cost
ASP= Average sale price of pineapple
AVC= Average variable cost

RESULTS AND DISCUSSION

Cost and returns

It is evident from Table 1 that the total cost incurred was found to be less in the second year of the orchard in all the categories. In small farm the first year cost was ₹23125.38, second year was ₹13987.58 and in third year it was ₹32692.26; in medium farm it was ₹30334.69, ₹16020.78 and ₹38348.23 in first, second and third year and in large farm it was ₹44080.09, ₹15965.27 and ₹41612.88. This crop generates negative returns during the initial two years and start giving positive returns from third year onwards. The gross returns of large farms were found more as compared to small and medium category farms. The productivity of pineapple orchard was found to be 18.68 t/ha, 18.70 t/ha and 21.99 t/ha on small, medium and large category. Net returns on small, medium and large farms were found to be ₹ 50795.07, ₹ 51637.23and ₹ 63401.94 respectively (Table 1 to 3). It indicates that the net returns in pineapple orchard increases with the increase of size of orchards, and it implies the principle of economies of scale. It is evident from the analysis that the orchard has to bear a loss of ₹ 32513.38 and ₹ 15324.54 in first and second year, respectively. During the third year the net return was ₹ 103116.01 and after that it becomes more or less stable up to 25 years. The share in total cost was found to be increasing with the age of plants which needs more inputs with the increasing age whereas, the share of land rent was more in initial as compared to second and third year and it was due to proportionate cost share increase in other items of total cost with the increase in age of plants.

Economic viability of pineapple orchard

The economic feasibility indicators of pineapple orchard are presented in Table 4. The B-C ratio was estimated as 1.61:1 for small, 1.48:1 for medium and 1.49:1 for the large category with an average ratio of 1.52:1. The benefit cost ratio was found to be more in the large category because of increase productivity of large farms. The B-C ratio analysis

Table 1: Cost and returns from pineapple orchard on small farms

Sl. no	Particulars	Years			Total cost	Average cost per annum (₹/ha)
		I	II	III		
1	Productivity (t/ha)	-	-	18.68		
2	Land rent	10000 (43.24)	10000(71.49)	10000(30.59)	30000(42.98)	10000(42.98)
3	Operational cost	2723.57(11.78)	3306.21(23.64)	16308.62(49.88)	22338.40(32.00)	7446.13(32.00)
4	Depreciation	182.62(0.79)	156.37(1.12)	224.80(0.69)	563.79(0.81)	187.93(0.81)
5	Interest on working capital (@ 7%)	1050.00 (4.54)	525.00(3.75)	1400(4.28)	2975.00(4.26)	991.66(4.26)
6	Establishment cost	9169.19 (39.65)	-	-	9169.19(13.13)	3056.39(13.13)
7	Marketing cost	-	-	4758.84(14.56)	4758.84(6.82)	1586.29(6.82)
8	Total cost (2 to 7)	23125.38(100)	13987.58(100)	32692.26(100)	69805.22(100)	23268.40(100)
9	Gross returns			120600.29	120600.29	40200.09
10	Net returns	-23125.38	-13987.58	87908.03	50795.07	16931.69

Note: Figures in parentheses are percentage of the total

Table 2: Cost and returns from pineapple orchard on medium farms

Sl. no	Particulars	Years			Total cost	Average cost per annum (₹/ha)
		I	II	III		
1	Productivity (t/ha)	-	-	18.70		
2	Land rent	10000(32.96)	10000(62.42)	10000(26.08)	30000(35.42)	10000(35.42)
3	Operational cost	2689.33(8.87)	5306.23(33.12)	23716.04(61.84)	31711.60(37.44)	10570.53(37.44)
4	Depreciation	266.04(0.88)	189.55(1.18)	284.97(0.74)	740.56(0.87)	246.85(0.87)
5	Interest on working capital (@ 7%)	1050(3.46)	525(3.28)	1400(3.65)	2975(3.51)	991.66(3.51)
6	Establishment cost	16329.32(53.83)	-	-	16329.32(19.28)	5443.11(19.28)
7	Marketing cost	-	-	2947.22(7.69)	2947.22(3.48)	982.40(3.48)
8	Total cost (2 to 7)	30334.69(100)	16020.78(100)	38348.23(100)	84703.70(100)	28234.56(100)
9	Gross returns	-	-	136340.93	136340.93	45446.97
10	Net returns	-30334.69	-16020.78	97992.70	51637.23	17212.41

Note: Figures in parentheses are percentage of the total

Table 3: Cost and returns from pineapple orchard on large farms

Sl. no	Particulars	Years			Total cost	Average cost per annum (₹/ha)
		I	II	III		
1	Productivity (t/ha)	-	-	21.99		
2	Land rent	10000(22.69)	10000(62.64)	10000(24.03)	30000(29.51)	10000(29.51)
3	Operational cost	4758.85(10.80)	5160.77(32.32)	22057.39(53.02)	31977.01(31.46)	10659.00(31.46)
4	Depreciation	325.55(0.74)	279.50(1.75)	467.59(1.12)	1072.64(1.05)	357.54(1.05)
5	Interest on working capital (@7%)	1050(2.38)	525(3.29)	1400(3.36)	2975.00(2.93)	991.66(2.93)
6	Establishment cost	27945.69(63.39)	-	-	27945.69(27.49)	9315.23(27.49)
7	Marketing cost	-	-	7687.90(18.47)	7687.90(7.56)	2562.63(7.56)
8	Total cost (2 to 7)	44080.09(100)	15965.27(100)	41612.88(100)	101658.24(100)	33886.08(100)
9	Gross returns	-	-	165060.18	165060.18	55020.06
10	Net returns	- 44080.09	-15965.27	123447.30	63401.94	21133.78

Note: Figures in parentheses are percentage of the total

Table 4: Break-even point, Net Present Value and Benefit Cost ratio of orchard

Category	Net Present Value	Benefit -Cost ratio	Break-Even point (t)	Payback period (Year)
Small	36149.10	1.61	2.23	0.85
Medium	35752.68	1.48	2.37	0.93
Large	43232.27	1.49	2.86	0.90
Average	38378.03	1.52	2.49	0.80

indicates that the investment in pineapple orchard is economically viable and on an average ₹1 investment brings ₹ 1.52 returns. The break-even point of small orchard was reached at 2.33 tonnes, 2.37 tonnes and 2.86 tonnes in small, medium and large category of orchard. Overall, the average break-even point was worked out to be 2.49 ton. Further, the payback period was estimated at 0.85 years in small orchard, 0.93 years in medium orchard and 0.90 years in large orchard from bearing year. Overall, it took 0.89 years after fruiting to repay back the investment incurred in the orchard.

Pineapple cultivation is capital intensive. It was found to be economically feasible in the state. The category wise economic analysis of pineapple

implies economies of scale. The Benefit Cost ratio was worked to be 1.61, 1.48 and 1.49 in small, medium and large category. The Break-Even point was at 2.33 tonnes in small category, 2.37 tonnes in medium category and 2.86 ton in large category. The payback period from fruiting was found to be 0.85 year, 0.93 year and 0.90 year in small, medium and large category of orchards. Thus, economic benefits of pineapple should be realised to the farmers to enhance the production and productivity of pineapple. Pineapple production in the region is organic by default, hence organic pineapple certification agencies should be initiated in the state. A suitable scientific package of pineapple in local dialect should be prepared for the pineapple growers.

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REFERENCES

Anonymous (2012). Pineapple: Organic pineapple. Agri News India. India's No. 1 Agricultural New Portal

Anonymous (2010). Directorate of Horticulture. 2010. Govt. of Meghalaya, Shillong

APEDA (2010). Area under fruits and vegetables.Ministry of commerce and Industry. Government of India

Chishi A (2010). Pineapple cultivation in North East India: A perspective venture.Central Institute of Horticulture. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India

NHB (2010). Indian Horticulture Database.National Horticultural Board. Ministry of Agriculture,Government of India

Radha T, Mathew L (2007). Fruit crops: Horticulture Science Series-3. Tropical fruits, pp 91- 116. Peter K V (Eds), New India Publishing Agency.

Reddy SS,RamRP(2010). Agricultural Finance and Management, pp 126-7. Oxford and IBH Publishing Co. Pvt .Ltd.

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Constraints Faced by the Farmers in Adoption of *Gmelina arborea* – A Case Study in Tamil Nadu

S. Saravanan

ABSTRACT

The present study was conducted to investigate and find out the problems faced by the *Gmelina arborea* tree growers in adoption of new species and the recommended silvicultural practices for the fast growing tree species in their farm land condition as a block plantation as well as in the form of agroforestry systems. *Gmelina* growers have planted the seedlings in recommended and appropriate techniques at appropriate time. The purchase of quality planting material from the authorized government nurseries and the practices of intercrops, casualty replacement, application of fertilizers, pest and disease management, etc. were studied. It was found that the recommended practices either did not reach the farming communities, or were not practiced by them. From this study, it was found that, most of the farmers do not purchase quality planting material. *Gmelina* growers are needed to be addressed and convinced about the usefulness of these silvicultural practices for higher economic returns. Being a new tree species introduced among the farming community, the cultivation techniques are to be brought out in local language to mare the farmers aware of higher economic returns from *Gmelina*. The major problems facing by the farming community are non-availability of quality planting material, high cost for seedling from private nursery, pest and disease management, marketing, etc.

Keywords: *Gmelina arbora*, Silvicultural practices, Farming community, Quality planting material

INTRODUCTION

Gmelina arborea is an indigenous fast growing tree species used mainly for timber and paper and pulp making. *Gmelina* is an unarmed, moderately sized to large deciduous tree with a straight trunk. It is spreading type with numerous branches forming a large shady crown, attains a height of 30 m or more and a diameter of up to 4.5 m. Timber is reasonably strong for its weight. It is used in constructions, furniture, carriages, sports, musical instruments and artificial limbs. In season, it is a very sturdy timber and moderately resistant to decay and termites. It grows faster in the seedling stage onwards. *Gmelina* is one of the important species identified by the Tamil Nadu Forest Department (TNFD) for the *Tree Cultivation in Private Lands* (TCPL) and *Tamil Nadu Biodiversity Conservation and Greening Project* (TBGP) to be planted in the farm lands. The growth and quality of the main stem in the farm fields mainly depends on edaphic and climatic factors, and silvicultural practices (Centeno 1997). As commercial tree plantations are a recent development, farmers who are facing many problems in practicing agriculture plant *Gmelina* in their farm land for various reasons,viz. high return, less risk, etc.

Because of its fast growing nature, less shade effect on agricultural crops and huge market demand for timber, this species was introduced and domesticated among the farming communities as a block plantation (pure crop) and under agroforestry system and widely established throughout Tamil Nadu and more concentrated in the western and southern zones of Tamil Nadu. *Gmelina* plantation is generally not followed by the farmers' due to the non availability of technical inputs and proper extension strategies. Therefore, this study was undertaken to study the extent of adoption of recommended silvicultural practices for raising the *Gmelina* plantation and to identify the constraints faced by the farming communities in adoption of these silvicultural techniques.

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MATERIALS AND METHODS

The present study was conducted in the western (Erode district) and southern zone (Pudukottai district) of Tamil Nadu. The list of individual *Gmelina* growers in both the districts was obtained from the TNFD. From each district, 120 farmers were selected for the above study, who had established the *Gmelina* plantations up to 2010-11. These *Gmelina* growers were the respondents for the present study. The respondents were interviewed with the pre-tested questionnaire. The information on recommended technologies and silvicultural practices like quality seedlings, type of soil, spacing, pit size, time of planting, irrigation, fertilizer application, intercropping, weeding, soil working, pest and disease management, etc. were collected. The responses about actual use of the above identified practices were obtained from the *Gmelina* growers.

RESULTS AND DISCUSSION

Reason for planting *Gmelina*

The reason for planting the *Gmelina* trees was analysed by the 'Garrett scoring Technique' (Garrett and Woodworth 1969) and the results are presented in Table 1. The farmers felt that, non availability of agricultural labour was the primary reason (mean score of 57.56) for opting *Gmelina* plantation. Further, high income within the short period ranked second with the mean score of 54.83. Less attention needed for *Gmelina* was the third important reason.

Table 1: Reason for planting *Gmelina*

Reason	Western zone (Erode district)		Southern zone (Pudukottai district)	
	Mean score	Rank	Mean score	Rank
1. Non availability of agricultural labour	57.56	I	58.62	I
2. Higher income	54.83	II	56.81	II
3. Less attention needed	50.75	III	55.25	III
4. Less risk	50.56	IV	53.65	IV
5. Inadequate water for other annual crops	46.93	V	49.53	V
6. Low input costs	45.28	VI	49.28	VI

Level of domestication and extent of adoption

Domestication isthe process whereby a population of plants is changed at the genetic level through a process of selection, in order to accentuate traits that benefit humans, and adoption is the actual use of recommended silvicultural practices by the growers. A critical look at the data of*Gmelina* growers adopting recommended practices of cultivation indicated that all *Gmelina* growers are aware of species and time of plantation (Table 2).

Table 2: Level of domestication and extent of adoption in *Gmelina*

Practices	Western zone (Erode district)		Southern zone (Pudukottai district)	
	Frequency (n=120)	Percentage	Frequency (n=120)	Percentage
1. Knowledge on tree cultivation	82	68.33	75	62.50
2. Quality planting material	25	20.83	22	18.33
3. Site selection	38	31.67	35	29.17
4. Proper soil selection	34	28.33	46	38.33
5. Type of planting material	75	62.50	80	66.67
6. Time of planting	62	51.67	72	60.00
7. Spacing	72	60.00	81	67.50
8. Digging of pit and size	95	79.17	90	75.00
9. Soil mixture	23	19.17	54	45.00
10. Irrigation	12	10.00	25	20.83
11. Soil working	10	08.33	15	12.50
12. Intercropping	74	61.67	83	69.17
13. Weeding	54	54.00	68	56.66
14. Mulching	05	04.17	04	03.33
15. Application of fertilizers	10	08.33	08	06.67
16. Plant protection measures	08	06.67	15	12.50

The analysis showed that around 60-70% of the farmers had knowledge on tree cultivation in general. But in the case of availability of quality planting material (QPM), less than 20% of the farmers were aware of the importance of the QPM and most of the farmers purchased in bulk poor genetic material of *Gmelina* seedlings from private nurseries at high rates. Site selection plays an important role in growth, form, etc. In this case, around 30% of the farmers made the correct choice for site and around 40% for proper soil selection. More than 60% of the farmers preferred container raised planting material for better root development and anchor and early establishment with the ball of

earth than the vegetative propagated material. The time of planting during the monsoon period is the most important factor for establishment and early growth and on an average, around 55% of farmers planted the *Gmelina* seedlings in the monsoon period. This is due to non-availability of planting material in the both government and private nurseries. Around 60% of the farmers planted *Gmelina* under wider spacing for intercropping and other cultural operations. This study reveals that three fourth of the farmers practiced the right dimensions of the pits for planting. After planting, farmers lack the proper knowledge for filling the pits with proper soil mixture (20% in Erode and 45% in Pudukottai). There is a common myth among the farmers that tree species do not require irrigation but grow on their own. Data obtained from Erode (10%) and Pudukottai (21%) confirms this. Further, farmers have very poor knowledge of cultural operations like soil working, mulching, etc.

Constraints in adoption

The problems faced by the farming communities in cultivation of *Gmelina* are given in Table 3. Among the difficulties, non availability of credits/ loan for tree cultivation is the major constrain (97%) unlike in agriculture. Even, loan facilities are not available for making drip irrigation facilities. Nimjeet al. (1991) also reported the non availability of loan as a major constraint in adoption of social forestry programmes.

Non availability of agricultural labour is another important constraint faced by the farming communities (80%) and their wages are very high (76.25%). In case of inputs, non-availability of QPM is the major constraint faced by the farmers (66.25%). Farmers often depend on private nurseries and are forced to buy *Gmelina* seedlings at the cost of ₹ 6-10/seedling, which is not at all affordable to farmers. Further, the cost for fertilizers (61.25%) also plays a major role in tree cultivation, and these applications increase the cost of cultivation. In case of marketing, proper marketing information is not available for many of the tree species including *Gmelina*. Local traders control the markets by fixing the prices for timber on tonnage basis and not in cubic feet due to which farmers face problems like low cost (53.33%) in selling their products. Also, *Gmelina* is an alternative species for pulp and paper making and the reported price offered (₹ 2000/t) is very low (65%). Most importantly, linkage between the tree growers is very poor; there is no cluster/association or federation among grower. Tewari (1991) also reported that lack of information to the tree growers was the major constraints in adoption of social forestry programmes. Dove (1998), Chauhan and Dhyani (1989), Muir and Casey (1989) and Bhople et al. (1991) observed that the lack of appropriate technologies is a major constraint in adoption of agroforestry.

Table 3: Constraints faced by *Gmelina* growers for adoption

S. No	Constraints	Frequency (n=240)	Percentage
1.	**Labour**		
	1. Non availability of agricultural labours	192	80.00
	2. Higher wages to labours	183	76.25
2.	**Inputs**		
	1. QPM.	159	66.25
	2. Cost of inputs like fertilizers	148	61.66
	3. Cost of insecticides and pesticides	88	36.66
3.	**Technology**		
	1. Non-availability of silvicultural techniques	145	60.42
	2. Poor extension strategy	201	83.75
4.	**Marketing**		
	1. Non availability of marketing information	188	78.33
	2. Monopoly in price fixation	128	53.33
	3. Low price for pulp wood	156	65.00
5.	**Loan/credit facility**		
	1. Non availability of tree loan	232	96.67
6.	**Others**		
	1. Linkage among the tree growing farmers	164	68.33
	2. Sale through Association/federation	196	81.67

Changes in land and tree tenure and improved access to markets in some countries have encouraged cultivation of fast growing trees by farmers as an integral part of their farming system, in small woodlots, in home gardens or in mixtures with other trees and agriculture crops as agroforestry. Commercial considerations and the desire to enhance overall profitability from the land are foremost in farmers' decision to cultivate fast growing species. The major concerns for small holders include availability of quality planting materials, assured demand and prices and access to information related to *Gmelina* establishment and management, subject matter specialist to deal with other related problems. Following points should be considered at the time of tree planting especially in High Density and Short Rotation (HDSR) intensity plantations.

1. Plantation establishment	1. Tree improvement and biotechnology 2. Site-species matching 3. Planting techniques 4. Improved site preparation techniques
2. Management aspects	1. Growth and yield under short rotation management 2. Silviculture including maintenance 3. Pest and disease management including application of biological control measures 4. Nutrient management
3. Harvesting and utilization	1. Wood quality 2. Utilization of small dimension logs and poles
4. Economics	1. Commercial profitability
5. Technical aspects	1. Cultivation techniques 2. Access to quality seeds, QPMandexpertise
6. Sociological aspects	1. Demand for wood 2. Easy access to markets 3. Economic and financial viability and profitability to the livelihood strategies

REFERENCES

Anonymous (1993). Manual on agro-climatic zones in Tamil Nadu. Directorate of Agriculture, Madras, Tamil Nadu, pp 13-16

Bhople RS, Sagane MA, Umale PB (1991). Adoption of Agroforestry by teak growers. Mah J ExtnEduX(1): 145-148

Centeno JC (1997). The management of teak plantations.http://www.ciens.ula.ve/icenteno

Chauhan DS, Dhyani SK (1989). Traditional agroforestry practices in North East Himalayan Region of India. Indian J Dry Land Agriculture Research and Development 4(2): 73-81

Dove MR (1988). Prospects for farm forestry in Pakistan. Part I: Village Land Determinants. Pakistan J Forestry 38(1): 12-22

Garrett HE, Woodworth RS (1969). Statistics in Psychology and Education. Bombay, Vakils, Feffer and Simons Pvt. Ltd., p 329

Muir K, Casey J (1989). Institutional responsibility for social forestry in Africa.Lesson from Zimbabwe. J Social Development in Africa 4(2): 27-37

Nimje NR, Sinha RR,Kahandhvi DP(1991). Adoption of social forestry programme by the teak growers. Mah J Extn Edu X (1): 99-105

Tewari DN (1991). Social forestry in India. The Indian Forester. 117(5): 293-308

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Screening of Varieties Against Soybean Rust Caused by *Phakopsora pachyrhizi* in Mid-hills of Meghalaya

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ABSTRACT

Screening trial was conducted for identification of resistant varieties/lines against soybean rust caused by *Phakopsora pachyrhizi* under natural epiphytotic conditions at Barapani, Meghalaya, India. Twenty three lines varieties/lines were included in the trial along with a susceptible check JS 335. Observations recorded were percent disease index, area under disease progress curve, apparent infection rate, defoliation and lesion type. Results revealed that only two lines NRC 80 and MAUS 417 were moderately susceptible. Lines TS 5, Himso 1676 and MAUS 282 were highly susceptible and all other lines were susceptible. No line or variety was in the moderately resistant or resistant category as all the lines exhibited Tan type lesions.

Keywords: Soybean, Resistant, Tan type, RB type

INTRODUCTION

Soybean (*Glycine max* L. Merril) is an important crop in India and it has been declared as a potential crop for northeast India including Meghalaya. It is used as oilseed, pulse and vegetable. It is also being considered as a component for increasing food security of rural households in northeast India. This crop also provides an added advantage of enhancing nitrogen status of soils through nitrogen fixation (Jaiswal et al. 2011).

Soybean rust caused by *Phakopsora pachyrhizi* is a major limiting factor in successful cultivation of soybean. Symptoms include presence of tan to dark brown or reddish brown lesions. Lesions are angular in appearance and restricted by veins. Lesions are also reported on pods, petioles and stems (Sinclair and Hartman 1999). Pod formation, pod filling are affected by heavy defoliation due to rust (Yang et al. 1991). In India it was first reported from Pantnagar in 1951 (Sydow et al.1906, Sharma and Mehta 1996). This disease was first reported from Upper Shillong in Meghalaya (Maiti et al. 1983). Among the different management strategies available for soybean rust, use of resistant varieties is considered to be the best and ecologically safe option. Keeping this in view, an experiment on screening of varieties for rust resistance was conducted for identifying resistant lines/varieties.

MATERIALS AND METHODS

Screening against soybean rust was conducted using twenty three varieties/lines in Plant Pathology field, ICAR Research Complex for NEH Region, Umiam, Meghalaya (Latitude 25°30′ N, Longitude 91°5′E, Elevation 1000 msl). Recommended agronomic practices for soybean cultivation were followed. Screening was done twice in the year 2008 and 2009.

Heavy infection pressure was created by planting a susceptible variety JS 335 as an infector row. Observations recorded were percent disease index (PDI), apparent infection rates and defoliation. Lesion type (RB-red brown- indicating resistant reaction or Tan- indicating susceptible reaction) was also recorded for all the varieties/ lines. Area under disease progress curve (AUDPC) was also estimated using the following formula-

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$$AUDPC = \sum_{i=}^{k} 1/2\ (S_i+S_{i+1})\ (t_{i+1}-t_1)$$

Where S*i* = Disease severity at the end of days i and k= number of successive evaluations of disease severity, t_i number of days after first observations. For calculating apparent infection rate following formula was used (Vanderplank 1963).

$$r = 2.3026/(t_2-t_1) \log_{10} X_2(1-X_1)/X_2(1-X_2)$$

where r is apparent infection rate, and x_1 and x_2 are proportions of the disease at time t_1 and t_2. Classification of lines was done according to PDI as mentioned by Srivastava and Gupta (2010) (Table 1).

Table 1: Categorization of reactions based on PDI

S.No.	PDI range	Category
1.	0	No lesions
2.	0.01-11.11	Highly resistant
3.	12.22-33.33	Moderately resistant
4.	34.44-55.55	Moderately susceptible
5.	56.66-77.77	Susceptible
6.	78.88-100	Highly susceptible

RESULTS AND DISCUSSION

Screening results revealed that varieties viz. AMS1, MACS 1188, DS 2614, MACS 1184, NRC 81, Himso 1678, NSO 39, and PS 1454 exhibited comparatively less percent rust severity (range 61.6-63.8). Apparent infection rate ranged from 0.06 to 0.11. MAUS 417 (46.2%) exhibited minimum rust severity with r value of 0.04 and moderate defoliation followed by NRC 80 (50.6%) with r value of 0.05 (Table 2). None of the lines/ varieties exhibited resistant reaction. Results were confirmed further by observations on lesion type (RB- resistant, Tan- susceptible) on the varieties due to rust and results revealed that all the varieties exhibited Tan type reaction (susceptible reaction). PDI for these varieties ranged from 72.6-85.8 and apparent infection rate ranged from 0.06 to 0.2. Maximum rust severity (85.8%) was recorded on Himso 1676 with apparent infection rate of 0.2 with heavy defoliation. Defoliation was recorded from moderate to heavy and it was also high in highly susceptible varieties. Area under disease progress curve (AUDPC) also was lowest in case of MAUS 417 (418) and NRC 80 (440) followed by MACS 1188 < DS 2614 < MACS1184 < AMS 19 < NRC 81 < PS 1454 < NSO 39 < Himso 1678 < BAUS 96 < NRC 79 < RKS 52 < TS 2 < MACS 1140 < NSO 383 < KDS 321 < JS(SH)2002-14 < Dsb 11 < Himso 1676 < MAUS282 < DS 2613 < TS 5. Results indicated that MAUS 417 and NRC 80 were moderately susceptible, lines TS 5, Himso 1676 and MAUS282 were highly susceptible and all other lines viz. PS 1454, BAUS 96, JS(SH)2002-14, TS 2, MACS1184, MACS 1140, DS 2614,NRC 79, NSO 383, NSO 39, DS 2613, Himso 1678, NRC 81, KDS321, RKS 52, MACS 1188, AMS 1 and Dsb 11 were susceptible. No line or variety was in the moderately resistant or resistant category (Table 2).

Several screening trials have been conducted by different workers for identification of resistant sources. A typical characteristic of resistant genotypes or cultivars is limited pathogen development or sporulation (Singh and Thapliyal 1977). In Brazil, Santa Rosa, FT-1 and Uniao were identified as resistant cultivars and all the varieties and germplasm from US were found to be susceptible during screening trials (Ribeiro et al. 1985). Asian Vegetable Research and Development Centre (AVRDC) had also screened over 9000 soybean accessions against rust but no immune cultivars have been identified (Tschanz et al. 1985). Twenty five germplasms had been screened by Sharma et al. (1997) and they reported that only EC 39685 and Himso 558-A showed resistant reaction. Lal et al. (2001) screened 286 soybean lines, including four differentials (PI 200492, PI 230970, PI 462312 and PI 459025) in Karnataka, India during kharif 2000. Twenty-five lines and three exotic lines (EC 439597, EC 439599 and EC 439609) showed resistant reactions to the disease. Four entries JS (S) 89-49, JS 80-20, PK 416 and JS (SH) 89-59 out of 60 soybean cultivars/lines, showed consistent resistance to *P. pachyrhizi*, whereas 13 entries showed moderate resistance in a screening trial conducted at Arunachal Pradesh under rainfed conditions (Bag

Table 2: Screening of different germplasm against soybean rust

Var/ Line	Rust (percent disease index)	Apparent infection rate (r) (per unit/day)	Defoliation	Area under disease progress curve	RB/TAN	Reaction
PS 1454	63.8	0.07	Moderate	550	TAN	Susceptible
BAUS 96	68.2	0.1	Moderate	561	TAN	Susceptible
MAUS 282	81.4	0.15	Heavy	660	TAN	Highly susceptible
JS(SH)2002- 14	72.6	0.1	Heavy	616	TAN	Susceptible
TS 2	72.6	0.11	Heavy	594	TAN	Susceptible
NRC 79	68.2	0.1	Heavy	561	TAN	Susceptible
NSO 383	72.6	0.1	Heavy	605	TAN	Susceptible
NSO 39	63.8	0.07	Moderate	550	TAN	Susceptible
DS 2613	72.6	0.06	Moderate	660	TAN	Susceptible
Himso 1678	66	0.09	Moderate	550	TAN	Susceptible
NRC 81	63.8	0.08	Moderate	539	TAN	Susceptible
TS5	85.8	0.17	Heavy	693	TAN	Highly susceptible
MACS 1184	63.8	0.09	Moderate	528	TAN	Susceptible
NRC 80	50.6	0.05	Moderate	440	TAN	Moderately susceptible
MAUS 417	46.2	0.04	Moderate	418	TAN	Moderately susceptible
MACS 1140	72.6	0.11	Heavy	594	TAN	Susceptible
DS 2614	63.8	0.11	Moderate	660	TAN	Susceptible
KDS 321	74.8	0.12	Heavy	605	TAN	Susceptible
RKS 52	72.6	0.12	Heavy	583	TAN	Susceptible
Himso 1676	85.8	0.2	Heavy	649	TAN	Highly susceptible
MACS 1188	61.6	0.13	Moderate	462	TAN	Susceptible
AMS 1	63.8	0.09	Moderate	528	TAN	Susceptible
Dsb 11	74.8	0.11	Heavy	627	TAN	Susceptible

2002). Twenty lines ('AGS 16', 'DS 17-2A', 'EC 39718', 'EC 95808', 'EC 100021', 'EC 110952', 'EC 389148', 'EC 389160', 'EC 389165', 'EC 389392', 'EC 391152', 'EC 391181', 'EC 393230', 'EC 393231', 'G 5', 'LEE', 'MACS 212', 'P 205', 'PLSO 40', 'TS 98-21') had been identified as resistant to rust, whereas 'EC 389160', 'EC 393230' and 'TS 98-21' were found to be highly resistant in a screening trial conducted by Rahangdale and Raut (2003) in Pune, Maharashtra, India. Rahangdale and Raut (2004) also conducted inheritance studies on rust resistance in soybean using 9 crosses involving 2 susceptible (Bragg and MACS 13) and 5 resistant (Ankur, PK 1029, TS 98-21, EC 389160 and EC 389165) genotypes and the results revealed that rust resistance is governed by a single dominant gene. In one of the two resistant x resistant cross combinations (TS 98-21 x EC 389160), two different genes imparting resistance were reported. In PK 1029 x EC 389165, no segregation for rust reaction was observed in any of the generations, which indicated the presence of the same gene for resistance in both parental lines. Three entries (JS 19, RPSP-728 and PK 838) were resistant, 16 entries were moderately resistant and the rest of the entries were susceptible to highly susceptible with the high location severity index of 4.46 and only one entry SJ 1 showed highly resistant reaction in a trial conducted at Chhattisgarh using 242 germplasm/ lines/cultivars of soybean under natural epiphytotic conditions (Verma et al. 2004). Five genes are known to provide vertical resistance against soybean rust *Rpp1* (PI200492 - Komata), *Rpp 2* (PI230970), *Rpp 3* (PI462312,-Ankur), *Rpp4* (PI459025- Big nan) (Hartman et al., 2005). Apart from this two recessive genes have also been reported to confer resistance against rust (Calvo et al. 2008). A new resistance locus *Rpp 5* has also been mapped by Garcia et al. (2008).

CONCLUSIONS

In the future emphasis needs to be given to screening of local germplasm if available and also inclusion of large number of lines or varieties for conducting more massive screening trials for identification of resistant lines which can be used as source in breeding programs or can be released directly if found suitable under these climatic situation.

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REFERENCES

Bag TK (2002). Field evaluation of soybean varieties/lines against rust under rainfed conditions. Ann Pl Prot Sci 10:168-169

Calvo ES, Kiihl ASR, Garcia A, Harada, Hiromoto DM (2008). Two major recessive soybean genes conferring soybean rust resistance. Crop Sci 48:1350-1354

Garcia A, Calvo ES, de Souza Kiihl RA, Harada A, Hiromoto DM, Vieira LGE (2008). Molecular mapping of soybean rust (*Phakopsora pachyrhizi*) resistance genes: discovery of a novel locus and alleles. Theor Appl Genet 117:545-553

Hartman GL, Miles MR, Frederick RD (2005). Breeding for resistance to soybean rust. Pl Dis 89:664-666

Jaiswal SK, Anand A, Dhar B, Vaishampayan A (2011). Genotypic characterization of phage- typed indigenous soybean bradyrhizobia and their host range symbiotic effectiveness. Environ microbiol. doi 10.1007/s00248-011-9950-4

Lal SK, Hegde V, Rana VKS (2001). Screening and utilization of soybean (*Glycine max* (L.) Merr.) genotypes for improving resistance against rust. Indian J Genet Pl Breed 61:287-288

Maiti S, Vishwadar, Verma RN (1983). Soybean rust in NEH India. Soybean Rust Newsletter 6:22-24

Rahangdale SR, Raut VM (2003). Evaluation of soybean germplasm lines for rust (*Phakopsora pachyrhizi*) resistance. Indian J Agric Sci 73:120-121

Rahangdale SR, Raut VM (2004). Genetics of rust resistance in soybean [*Glycine max* (L.) Merrill]. Indian J Genet Pl Breed 64:121-124

Ribeiro DV, Zambolim FXL, Chaves GM (1985). Reaction of soybean cultivars to *Phakopsora pachyrhizi* Sydow. Soybean Rust Newsletter 7:10-13

Sharma ND, Mehta SK (1996). Soybean rust in Madhya Pradesh. Act Bot Indica 24:115-116. Sharma SK, Verma RN, Chauhan. S (1997)

Sharma SK, Verma RN, Chauhan. S (1997).Variation in soybean rust (*Phakopsora pachyrhizi*) development at two locations in Meghalaya. J Hill Res 10: 202-204

Sinclair JB, Hartman GL (1999). Soybean diseases.In: Compendium of soybean diseases (eds. Hartman GL., Sinclair JB. and Rupe JC). 4 ed. St. Paul. American Phytopathological Society. pp: 3-4

Singh BB, Thapliyal PN (1977). Breeding for resistance to soybean rust in India. In: Rust of Soybean : The problem and research needs (eds. Ford RE and Sinclair JB.) Report of Urbana-Champaign, IL, University of Illinois, USA. pp 81-83

Srivastava SK, Gupta GK (2010) Proceedings and technical programme 2009-10. Directorate of Soybean Research, Indore. pp 1-79

Sydow H, Sydow P, Butler EJ (1906). Fungi Indiae orientalis. Part 1. Sydowia: Ann Mycol 4:425-445

Tschanz AT, Wang TC, Tsai BY (1985). Recent advances in soybean rust research. In: Tropical and Sub-Tropical Cropping Systems. Proc of the Shanhua, Taiwan, AVRDC. pp 237–245

Vanderplank JE (1963). Plant Diseases: Epidemics and Control. Academic Press, New York

Verma KP, Thakur MP, Agarwal KC, Khare N (2004). Occurrence of soybean rust: some studies in Chhattisgarh state. Indian J Mycol Pl Pathol 34:24-27

Yang XB, Tchanz AT, Dowler WM, Wang TC (1991). Development of yield loss models in relation to reductions of components of soybeans infected with *Phakopsora pachyrhizi*. Phytopathology 81:1420-1426

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Effect of Integrated Nutrient Management Modules on Growth, Yield and Quality Attributes in Taro (*Colocasia esculenta* L. Schott)

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ABSTRACT

An investigation was carried out to evaluate the effect of different organic manures on growth, yield and quality attributes in taro at ICAR Research Complex for NEH Region, Umiam, Meghalaya during April to October 2011under rainfed condition. Seven treatment combinations were evaluated on taro cultivar BCC-1 in randomized complete block design with three replications.The highest petiole length, number of cormels, length, diameter and weight of corms as well as cormel were recorded from the treatment T_3 {vermicompost (1t/ha) + Full FYM (10t/ha) + 75% recommended dose of NPK} which was statistically at par with T_2 {vermicompost (1t/ha) + Full FYM (10t/ha) + 50% recommended dose of NPK}. The highest yield (18. 47 t/ha) was also recorded in INM treatment T_3closely followed by T_2(18.10t/ha). However, organic treatment T_4 {FYM (10 t/ha) + neem cake (1t/ha)} showed highest dry matter (27.29%) and starch (17.06%) content.

Keywords: Taro, Vermicompost, Neem cake, Mustard cake, Dry matter and Starch.

INTRODUCTION

Taro (*Colocasia esculenta* L. Schott) is an important staple food crop grown throughout many Pacific island countries, parts of Africa, Asia and the Caribbean for its fleshy corms and nutritious leaves. The corm is an excellent source of carbohydrate, the majority being starch of which 17-28% is amylose, and the remainder is amylopectin. All parts of the colocasia are consumed,*viz*. the leaves, petioles, corm and cormels for curry preparation, corms for snacks, baby feed and pig feed,etc. Taro is thought to have originated in North Eastern India and Asia (Kuruvilla and Singh 1981; Ivancic 1992) and gradually spread worldwide by settlers. It is widely grown as a rainfed crop in the valley and *Jhum* area in entire North Eastern States of India. The productivity of taro in the region is very low due to non-availability of quality planting materials and no or limited uses of organic and inorganic fertilizers.

The information regarding nutritional requirement of this crop is very scanty. To improve the yield and quality of taro, there is a need to standardize the optimum dose of nutrients for improving the physico-chemical properties of soil as well as yield and quality of produce. The integrated nutrient management (INM) approaches not only improve the quality of the produce but also help in improving the soil fertility including the biosphere. In addition, they are eco-friendly, easily available and cost-effective. Therefore, it becomes essential to integrate the chemical fertilizers and organic manures. Thus, the present investigation has been carried out to study the response of the crop to integrated nutrient management modules.

MATERIALS AND METHODS

The present experiment was conducted during April to October 2011, at Horticulture Farm of ICAR Research Complex for NEH Region, Umiam, Meghalaya. Weather parameters of the area are shown in Table 1. The soil type is alfisol with sandy loam texture and acidic in reaction(pH 5.8). The experiment was carried out under rainfed condition using taro cultivar BCC-1 with seven treatments and three replications under Randomized Complete Block Design. The sprouted cormels were planted at 45x45cm spacing. The treatments were (T_1) vermicompost (1t/ha) + full FYM (10t/ha)+ 25% recommended dose of NPK (80: 60: 80 kg/ha), (T_2) vermicompost (1t/ha) + full FYM + 50%

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Table 1: Crop weather parameters of taro cultivated during April 2011 to March 2012

Month	Temp, ^{0}C (Max)	Temp, ^{0}C (Min)	Rainfall, (mm)	RH, % (Morn)	RH, % (Eve)	Sunshine Hrs	
						Total	Average
2011							
April	27.85	14.44	177.80	75.00	67.53	173.70	5.79
May	28.86	17.05	429.90	84.29	73.29	142.70	4.68
June	28.92	19.50	635.10	88.77	75.13	102.60	3.42
July	28.93	19.74	340.40	89.13	76.42	72.70	2.57
August	29.17	19.51	380.80	91.35	74.58	97.00	3.38
Sept	29.43	18.82	276.30	89.93	78.80	122.10	4.07
Oct	28.55	15.55	187.90	86.65	73.06	199.10	6.62
Nov	24.25	9.23	101.30	82.47	65.03	205.60	6.85
Dec	22.07	6.91	12.30	85.55	61.94	182.20	6.12
2012							
Jan	18.51	5.35	32.90	84.22	68.12	177.32	5.72
Feb	22.97	7.23	Nil	79.34	50.44	221.56	7.64
March	26.90	12.02	1.80	77.61	46.90	216.69	6.99

recommended dose of NPK, (T_3) vermicompost (1t/ha) + full FYM + 75% recommended dose of NPK, (T_4) FYM (10 t/ha) + neem cake (1t/ha), (T_5) FYM (10 t/ha) + mustard cake (1t/ha), (T_6) recommended dose of FYM + NPK @ 80: 60: 80 kg/ha and (T_7) as control without any supplement of manure and fertilizers. The observations were recorded for fourteen growth, yield and quality related traits. The observations for growth and yield related traits were petiole length (cm), number of petioles, number of side shoots, number of cormels and yield per plant, length (cm), diameter (cm) and weight (g) of corm and cormels and yield (t/ha). The observation for quality traits were dry matter (%) and starch (%) content. The dry matter (%) was estimated based on fresh and dry weight basis. The samples were oven dried to constant weight at 60^{0}C. Starch content analyses was carried out after removal of sugars by 80% ethanol, the samples were hydrolysed into glucose and estimated by phenol-sulphuric acid method. The mean data obtained from six randomly selected plants in each replication were statistically analysed by SAS software and the mean differences were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

The results of present investigation showed significant differences for all the traits(Table 2). The maximum petiole length (70.34cm) was noticed in treatment T_3 followed by T_2 (68.91cm) and T_6 (67.21cm). However, treatments T_2 and T_6 were statistically at par with T_3. While the lowest petiole length (56.94 cm) was in T_7 (control) where plots were deprived off the use of any INM treatments. Similarly, the maximum number of petiole per plant was in treatment T_3 (12.33) followed by T_2 (12.16) and both treatments were statistically at par as well as significant over T_7.

The highest number of side shoots per plant was observed from the treatment T_3 (3.50) which were statistically at par with treatment T_4 (3.19). However, the lowest number of side shoot was recorded from T_7 (1.83). Likewise, maximum number of cormels per plant was recorded from T_3 (7.90) which were statistically at par with T_2 (7.64) and the lowest number was in T_7 (control).

The highest length (7.54cm), diameter (4.56cm) and weight of corm (75.77g) were recorded from the treatment T_3. However, the lowest length (5.38cm), diameter (3.37cm) and weight of corms (51.94g) were recorded from treatment T_7. However, T_2 was at par with T_3 for length, diameter and weight of the corm. Similarly, the highest length, diameter and weight of cromels 7.29(cm), 2.33 (cm) and 23.69 (g) respectively, were also recorded from the treatment T_3 and treatment T_2 was at par with T_3 for cormel length (7.25cm), cormel diameter (2.32cm) and weight (23.37g). The lowest length, diameter and weight of corm and cormels were recorded from the T_7 (control).

For economic traits yield per plant and yield per hectare (346g and 18.47t, respectively) was highest in treatment T_3 followed by T_2 ie. 338g and 18.10t,

Table 2: Effect of integrated nutrient management on yield and quality attributes of taro cultivar BCC-1

Treatment	Petiole length	No of petioles	No. of Side Shoots/ plant	No. of cormels / plant	Corm length (mm)	Corm diameter (mm)	Average corm wt. (g)	Cormel length (mm)	Cormel diameter (mm)	Cormel wt (g)	Yield/ plant (g)	Yield (t/ha)	Dry Matter (%)	Starch (%)
T_1	64.62^{bc}	10.06^{b}	2.08^{de}	5.50^{bc}	6.95^{bc}	3.83^{bc}	68.65^{d}	6.74^{b}	2.15^{b}	19.88^{c}	217.0^{c}	12.36^{d}	24.75^{bdc}	16.90^{a}
T_2	68.91^{ab}	12.16^{a}	2.55^{cd}	7.64^{a}	7.20^{ab}	4.23^{ab}	74.16^{ab}	7.25^{a}	2.32^{a}	23.37^{a}	338.0^{a}	18.10^{a}	23.22^{d}	15.27^{c}
T_3	70.34^{a}	12.33^{a}	3.50^{a}	7.90^{a}	7.54^{a}	4.56^{a}	75.77^{a}	7.29^{a}	2.33^{a}	23.69^{a}	346.0^{a}	18.47^{a}	23.79d^{c}	14.08^{d}
T_4	61.24^{c}	9.66^{b}	3.19^{ab}	5.80^{b}	7.24^{ab}	4.52^{a}	73.66^{bc}	6.72^{b}	2.15^{b}	21.64^{b}	288.0^{b}	14.61^{b}	27.39^{a}	17.06^{a}
T_5	62.25^{c}	10.60^{b}	2.72^{bc}	5.00^{cd}	6.43^{c}	4.13^{bc}	72.44^{c}	6.61^{b}	2.12^{b}	20.85^{bc}	280.0^{b}	13.34^{c}	26.44^{ab}	16.54^{b}
T_6	67.21^{ab}	9.70^{b}	2.66^{c}	4.58^{d}	6.45^{c}	3.70^{dc}	70.00^{d}	6.66^{b}	2.13^{b}	20.00^{c}	278.0^{b}	13.53^{c}	22.74^{d}	12.37^{e}
T_7	56.94^{d}	7.60^{c}	1.83^{e}	4.89^{d}	5.38^{d}	3.37^{d}	51.94^{e}	5.1^{c}	1.63^{c}	12.79^{d}	136.51^{d}	5.97^{e}	25.42^{abc}	11.27^{f}
Mean	64.50	10.30	2.65	5.90	6.74	4.05	69.52	6.62	2.12	20.29	269.58	13.92	24.82	14.78
CV (%)	3.72	7.55	10.09	5.32	4.60	5.90	1.34	4.06	4.09	4.42	2.99	2.59	1.23	0.03
LSD (0.05)	4.27	1.39	0.48	0.53	0.55	0.43	1.67	0.48	0.15	1.60	14.36	0.42	1.97	0.36

Means sharing the same letter(s) are statistically non-significant at 5% probability level

(Where: T_1=vermicompost (1t/ha) + full FYM (10t/ha)+ 25% recommended dose of NPK (80: 60: 80 kg/ha), T_2=vermicompost (1t/ha) + full FYM + 50% recommended dose of NPK, T_3=vermicompost (1t/ha) + full FYM + 75% recommended dose of NPK, T_4= FYM (10 t/ha) + neem cake (1t/ha), T_5= FYM (10 t/ha) + mustard cake (1t/ha), T_6= recommended dose of FYM + NPK @ 80: 60: 80 kg/ha and T_7= control)

respectively and was statistically at par with T_3. The lowest yield (136.51g/plant and 5.97t/ha) were recorded from the treatment T_7. There was no significant difference for yield per hectare between the treatments T_2:T_3 and T_5:T_6.

The results on quality analysis revealed the highest dry matter content (27.39%) from the treatment T_4 followed by T_5 (26.44%), T_7 (25.42%) and T_1 (24.75%). However T_4, T_5 and T_7 were statistically at par for dry matter content. Likewise, starch content (17.07%) was also highest in the treatment T_4 (Fig.1)which was statistically at par with T_1 (16.91%).

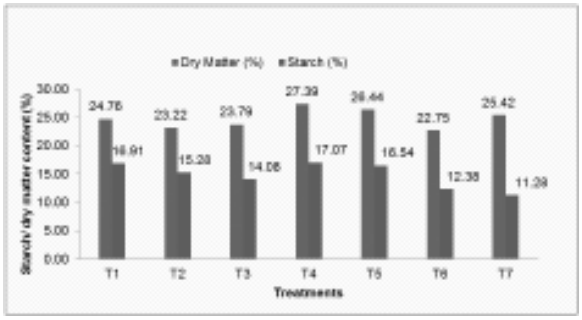

Fig. 1: Effect of INM on starch and dry matter content in taro

From the above results,treatment T_3 (Vermicompost (1t/ha) + Full FYM + 75% recommended dose of NPK) found to be the best integrated nutrient management module for petiole length, number of petioles, number of side shoots, number of cormels per plant, size and weight of corm as well as cormels and yield per plant and per hectare followed by T_2 (Vermicompost (1t/ha) + Full FYM + 50% recommended dose of NPK). However, both the treatments are statistically at par for these growth and yield related traits. Sen et al. (2007) also reported highest stolon yield in swamp taro with organic (25%) and inorganic (75%) source of nitrogen combination. Suthar(2009) also observed the maximum range of some plant parameters i.e. root length, shoot length, leaf length, fresh weight, number of cloves in garlic were in the treatment using 15t/ha vermicompost + 50 % NPK and Mondal et al.(1993) observed better net production values in potato when 75% RDF was applied together with FYM @ 10 t per ha. The increased mean growth and yield attributing traits by the application of NPK with FYM and vermicompost was attributed to solubilization effect of plant nutrients by the addition of FYM and vermicompost leading to increased uptake of NPK as reported by Nair and Peter (1990) in chilli.

The quality traits like dry matter content was highest in T_4 (FYM (10 t/ha) + neem cake (1t/ha) followed by T_5 (FYM (10 t/ha) + Mustard cake (1t/ha). Sable et al.(2007) also reported significantly higher T.S.S and shelf life when vermicompost and neem cake were applied in tomato.

For organic production of taro, treatment T_4 i.e.FYM (10 t/ha) + neem cake (1t/ha) showed significantly higher yield and quality attributes over T_5 which comprises of FYM (10 t/ha) + Mustard cake (1t/ha). This may be due to extended availability of nitrogen to the crop by slow releasing neem cake which is an effective nitrogen inhibitor and also having pesticidal properties. Kamal et al. (2012) also reported the highest dry weight of root (7.32 g), dry weight of rhizome per plant (40.35 g) and total dry matter yield (6.85 t/ha) from neem cake applied @ 2.0 t/ha in turmeric.

In conclusion, for higher yield and related attributes application of vermicompost (1t/ha) + FYM (10t/ha) + 50% recommended dose of NPK (80:60:80)has been found suitable. However, for organic production system, use of FYM (10 t/ha) + neem cake (1t/ha) is recommended for improved yield and quality traits.

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REFERENCES

Ivancic A (1992). Breeding and genetics of taro (*Colocasia esculenta*(L.) Schott. Ministry of Agriculture and Lands, Solomon Islands UNDP, Food and Agriculture Organizations of the United Nations,pp 1-97

Mondal SS, Chettri M, Sarkar S,Mondal TK (1993). Integrated nutrient management with sulphur bearing fertilizer, FYM and crop residues in relation to growth and yield of potato. J. Indian Potato Assoc. 20(2):139-143

Kuruvilla KM, Singh A (1981). Karyotypic and electrophoretic studies on taro and its origin. Euphytica 30: 405-413

Kamal MZU,Yousuf MN (2012). Effect of Organic Manures on Growth, Rhizome Yield and Quality Attributes of

Turmeric (*Curcuma longa* L.). The Agriculturists 10 (1): 16-22

Nair M, Peter KV (1990). Organic, inorganic fertilizers and their combinations on yield and storage life of hot chilli. Veg Sci 17: 7- 10

Sable CR, Ghuge TD, Jadhav SB, Gore AK (2007). Impact of organic sources on uptake, quality and availability of nutrients after harvest of tomato. J Soils and Crops 17(2): 284-287

Sen H, Mukherjee P, Mukherjee A (2007). Crop response of swamp taro to organic source of nitrogen in lower gangetic plains. Proc. of the 13th ISTRC Symposium, pp 170-176

Sen H, Das S,Dwivedi AK(1998). Stolon production of swamp taro (*Colocasiaesculenta*L. Schott) as influenced by different organic and inorganic nitrogenous fertilizers.J Root Crops 24: 81-84

SutharSurindra(2009).Impact of vermicompost and composted farmyard manure on growth and yield of garlic (*Allium sativum* L.) field crop. Int J Plant Prod 3(1): 27-38

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Variable Lime Requirement Based on Differences in Organic Matter Content of Iso-acidic Soils

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ABSTRACT

Understanding the factors affecting lime requirement (LR) is important for soil acidity management. Twenty samples with almost similar pH (4.51±0.05) but varying widely in organic matter (OM) and clay contents were selected for studying the importance of OM and clay content in determining the LR of acidic soils. Despite the iso-acidic nature of these soil samples, there were more than three-fold variations in the LR which ranged between 5.6 to 18 t ha^{-1}. Interestingly, the highest values of buffering capacity index (BCI=1.49) and LR (18 t ha^{-1}) was associated with the soil with highest OM content (4.89%). Similarly; the lowest BCI (0.55) and LR (5.6 t ha^{-1}) was found in the soil having the lowest OM content (1.03%). OM content of soil was strongly correlated with BCI (r= 0.824**, p< 0.01) and LR (r= 0.862**, p< 0.01). Regression analysis also showed strong dependence of BCI (R^2=0.678) and LR (R^2=0.743) on soil OM content. Clay content did not correlate with BCI or LR of the soils. Results suggest that the LR of the soils even with similar pH may vary drastically based on differences in their OM content.

Keywords: Buffering capacity, Lime requirement, North-east India, Soil acidity management

INTRODUCTION

Acid soils occupy more than 30% of the world's ice-free land and nearly 50% of the potentially arable land (von Uexkull and Mutert 1995). About 68% of these soils occur in the humid tropics. In India, nearly 25 million hectares of land are having pH below 5.5 and 23 million hectares fall under the pH range of 5.6-6.5 (Mandal 1997). Majority of these soils (54%) are concentrated in North Eastern Region (NER) of India where more than 95% area is affected by soil acidity, with around 65% of the area being under extreme forms of soil acidity (pH below 5.5) (Sharma and Singh 2002). Crop productivity on such a soil is mostly constrained by aluminium (Al) and iron (Fe) toxicity, phosphorus (P) deficiency, low base saturation, impaired biological activity and other acidity-induced soil fertility and plant nutritional problems (Manoj-Kumar 2011). Because of these constraints, despite having ~6% of the total geographical area and ~13% of the total rainfall in the country, the NER contributes only 1.5% to the national food grain production (Singh and Satapathy 2007). Amelioration of soil acidity is, therefore, accorded top priority for enhancing crop productivity and ensuring food security of the region.

Application of lime is a widely recommended practice for amelioration of soil acidity and alleviation of acidity-induced soil fertility and plant nutritional problems (Haynes 1984; Patiram 1991). Since liming involves a considerable cost in crop production on acid soils, knowledge of its required amount to be applied for raising the soil pH to a target level (lime requirement) is important. There is a general impression among the farmers and the extension workers that the soils with low pH require high amount of lime application and vice-versa, which may not be always correct. In fact, the existing soil pH is just an indication, whether liming is required or not; it does not suggest the actual amount of lime required to raise the soil pH to a desired level. Lime requirement depends largely on cation exchange capacity (CEC) of soils. Soils with high CEC possess high buffering capacity, and therefore, more amounts of lime is required to cause a unit increase in pH of such soils. The CEC and hence the buffering capacity of soils are mostly determined by their organic matter and clay

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contents. Therefore, the lime requirements for the soils with high organic matter and clay contents can also be expected to be high, and *vice-versa* (Keeney and Corey 1963; Ross et al. 1964; Aitken et al. 1990; Husni et al. 1995; Pagani and Mallarino 2012).

Soil acidity in the northeastern region of India is mostly caused by excessive rainfall, the other management factors, including chemical fertilization being relatively less important. Thus, soils with the acidity levels falling within a narrow range can be found over a fairly large area receiving a similar amount of rainfall (barring some latitudinal and geologically-borne differences). However, since organic matter content of soil (SOM) is highly subjective to management practices, even field-to-field variation in SOM content (and hence the soils buffering capacity) within an area may not be uncommon. This implies that although the soils of an area may have similar acidity (pH) levels, their lime requirement may vary considerably based on differences in organic matter and also the clay contents. If so, the blanket dose of lime application cannot be recommended in an area; rather, lime requirement must be worked out for the individual fields for the best result. In this backdrop, the present study aims to test the above-laid hypothesis in the acidic soils of Meghalaya, North-East India. In this study using the soils with similar acidity levels (iso-acidic soils with pH 4.51±0.05), we have attempted to provide an evidence for the fact that even the soils with similar acidity levels may vary drastically in their lime requirement based on their differential buffering capacity caused by differences in organic matter content.

MATERIALS AND METHODS

From a pool of around 400 soil samples (0-20 cm depth) collected from across the seven districts of Meghalaya, India; 20 samples with almost similar acidity levels (mean pH 4.51) were selected for this study. These soils are hereafter referred to as "iso-acidic soils". While selecting the samples, due care was taken to accommodate a wide variability in soil organic matter and clay contents therein. The soil samples were processed and analyzed for pH, organic carbon, particle size distribution, lime requirement and other related variables. These parameters of the selected iso-acidic soils along with their summary statistics are shown in Table 1 and 2, respectively.

Table 1: Experimental soils (20 cm depth) with their pH, organic matter and clay content, and the lime requirement related variables

Sample No.	pH (1:2)	Buffer pH (BpH)	ÄpH (BpH-pH)	BCI (1/ÄpH)	LR (t ha^{-1})	Organic matter (%)	Clay (%)	Textural class
1	4.42	5.99	1.57	0.64	9.48	2.40	20.6	SL
2	4.5	5.17	0.67	1.49	17.98	4.89	23.3	SCL
3	4.46	5.42	0.96	1.04	15.79	4.34	24.0	SL
4	4.51	5.69	1.18	0.85	12.64	3.28	22.6	L
5	4.54	5.62	1.08	0.93	13.61	3.39	28.6	SCL
6	4.49	5.84	1.35	0.74	11.66	2.77	21.3	SCL
7	4.45	6.06	1.61	0.62	8.5	2.09	20.6	SCL
8	4.57	5.70	1.13	0.88	12.64	2.64	23.3	SCL
9	4.48	6.05	1.57	0.64	8.5	1.81	23.3	SCL
10	4.56	6.38	1.82	0.55	5.59	1.03	19.3	SL
11	4.6	6.15	1.55	0.65	7.53	1.14	22.6	SCL
12	4.57	5.91	1.34	0.75	10.69	2.59	24.6	SCL
13	4.59	5.92	1.33	0.75	10.69	2.04	19.3	SL
14	4.49	5.84	1.35	0.74	11.66	2.74	32.6	SCL
15	4.52	5.84	1.32	0.76	11.6	2.09	26.6	SCL
16	4.42	5.82	1.4	0.71	11.6	2.07	30.6	SCL
17	4.58	6.09	1.51	0.66	8.5	1.32	34.6	SCL
18	4.49	5.94	1.45	0.69	10.69	2.04	34.0	SCL
19	4.48	5.42	0.94	1.06	15.79	3.88	20.6	SCL
20	4.5	5.49	0.99	1.01	14.58	1.76	28.6	SCL

BCI: Buffer capacity index; LR: Lime requirement in terms of pure $CaCO_3$; SL: Sandy loam; L: Loam; SCL: Sandy clay loam

Table 2: Summary statistics of the parameters involved in the study (n=20)

Parameters	Mean	Minimum	Maximum	Std. Deviation
pH (1:2 soil-water)	4.51	4.42	4.60	0.05
BpH	5.82	5.17	6.38	0.29
ÄpH	1.31	0.67	1.82	0.28
BCI	0.81	0.55	1.49	0.22
LR (t ha^{-1})	11.47	5.59	17.98	3.07
OM (%)	2.52	1.03	4.89	1.02
Clay (%)	25.02	19.28	34.56	4.86

BCI: Buffer capacity index; LR: Lime requirement in terms of pure $CaCO_3$; OM: organic matter

Soil pH (1:2 soil-water suspension) was measured using glass electrode. Organic carbon was determined by wet digestion method (Walkley and Black 1934) and the organic matter content was calculated using a conversion factor of 1.724. Particle size analysis was done by hydrometer method (Bouyoucos 1962). Lime requirement (for a target soil pH 6.0) was estimated using SMP buffer method (Shoemaker et al. 1961). SMP buffer acts as a quick acting liming material. Upon its addition (and equilibration) to soil, the pH of soil-buffer mixture increases, and the magnitude of increase depends on the buffering capacity of soil. Soil with high buffering capacity (high reserve acidity) allows less change in pH, and *vice-versa*. Therefore, difference in the soil-buffer pH and the initial soil pH (ÄpH) indicates buffering capacity of the soil. Higher the ÄpH, lower would be the buffering capacity, and *vice versa*. To simplify the relationship further, reciprocal of the ÄpH was taken as an index of soil buffering capacity, hereafter referred to as "Buffering Capacity Index" (BCI). Lime requirement has been expressed in terms of pure $CaCO_3$. Pearson's correlation coefficients were used to determine the strength of relationships among the various soil attributes, lime requirement and related variables. All the statistical analyses were performed using SPSS version 16.0 software.

RESULTS AND DISCUSSION

As hypothesized at the beginning of this study, variations in organic matter content of soils did exert significant influence on the lime requirements of the iso-acidic soils used in the study. Table 1 and 2 show that initial pH of the soils were almost similar, with a mean pH of 4.51 and standard deviation of ±0.05. Despite the iso-acidic nature of these soils, their lime requirement varied drastically. In fact, there were more than three-fold variations in the lime requirement which ranged between 5.6 to 18 t ha^{-1}. Interestingly, the highest lime requirement (18 t ha^{-1}) was associated with the soil (sample no. 2) with highest organic matter content (4.89%). The change in soil pH upon addition of SMP buffer (ÄpH) was also found lowest (0.67) in the same soil, which indicates its highest buffering capacity. It is clearly reflected by the highest buffering capacity index (BCI) of this soil (1.49). Similarly, the highest magnitude of ÄpH (1.82), the lowest BCI (0.55), and thereby the lowest lime requirement (5.59 t ha^{-1}) were all associated with the soil (sample no. 10) having the lowest organic matter content (1.03%). The strong correlations of the soils' organic matter content with their BCI ($r= 0.824^{**}$, $p< 0.01$) and the lime requirement ($r= 0.862^{**}$, $p< 0.01$) are amply evident in the correlation matrix shown in Table 3. The role of soil's buffering capacity in deciding the lime requirement is also evident from their strongly positive correlation ($r= 0.922^{**}$, $p< 0.01$).

The dependence of lime requirement on buffering capacity of the soil and that of buffering capacity on soil organic matter content can be better appreciated by their relationships shown in Fig. 1. A large proportion of the variability in soils buffering capacity was explained by organic matter content ($R^2= 0.6785$). Similarly, BCI accounted for 85% of the lime requirement, and the organic matter

accounted for 74% of the variability in lime requirement. Clay content, though often considered an important factor governing the soils buffering capacity and the lime requirement, was not significantly correlated with any of the parameter related to lime requirement of the soils in present study (Table 3).

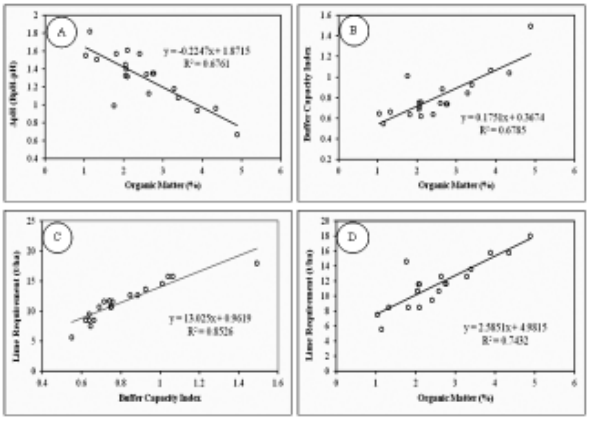

Fig.1: Relationships among the organic matter content, buffering capacity index and lime requirement of the soils under study (n=20)

The importance of organic matter as a determinant of lime requirement in iso-acidic soils, as observed in our study, can be attributed to its contribution in the buffering capacity of soil which, in turn, is governed by the CEC of the soil. High organic matter containing soils, by virtue of their higher CEC, can possess more amount of reserve acidity, neutralization of which requires higher amount of lime application. The strong correlation between soil organic matter content and lime requirement has also been reported by Keeney and Corey (1963), Ross et al. (1964), Aitken et al. (1990), Husni et al. (1995), and recently by Pagani and Mallarino (2012). Keeney and Corey (1963) working with incubation experiments in Missouri, correlated lime requirement with various soil properties. They reported that SMP buffer pH was the best single predictor variable for lime requirement (r = 0.95), which was also observed in our study (Table 3). Their results also showed that both organic matter and soil pH explained the largest proportion of variation in lime requirement across soils compared to initial soil pH alone. In our study, initial soil pH did not correlate with lime requirement because the soils were iso-acidic in nature, while the effect of organic matter was quite evident (Table 2&3, Fig.1).

Considering the importance of organic matter in determining the lime requirement of soil, a combined parameter was calculated as the desired target pH minus initial soil pH multiplied by organic matter content (Keeney and Corey, 1963). The combined parameter was well correlated (r = 0.88) to lime requirement. Because most routine soil testing laboratories measure pH and organic matter in soil samples, they proposed that lime requirement could be predicted using an equation based on soil pH, target pH, and organic matter content. Having witnessed similar results in our study, such equations may also be developed for calculation of lime requirement for the acidic soils of northeast India.

Although clay content is also considered to exert the similar influence, such effect was not observed in the present study, which may be due to the fact that variability in clay content of the soils under study was not as pronounced as that in organic matter contents, and thus the possible impact of clay might have been masked by that of organic matter. Also, since organic matter content of soils in the study area is relatively higher, much of the soils CEC and buffering capacity may be expected

Table 3: Correlations of lime requirement and related variables with organic matter and clay content of the iso-acidic soils under study (n=20)

	pH	BpH	ÄpH	BCI	LR	OM	Clay
pH	1						
BpH	0.266	1					
ÄpH	0.082	.982**	1				
BCI	-0.093	-.940**	-.954**	1			
LR	-0.263	-.995**	-.978**	.922**	1		
OM	-0.325	-.856**	-.822**	.824**	.862**	1	
Clay	-0.035	-0.042	-0.037	-0.043	0.072	-0.148	1

** Correlation is significant at the 0.01 level (2-tailed). BCI: Buffer capacity index; LR: Lime requirement; OM: organic matter

to result from the soil organic matter rather than the clay contents, and this explains the observed dominance of organic matter over clay in determining the lime requirement of iso-acidic soils in present study.

CONCLLUSIONS

Lime requirement of the soils even with similar acidity (pH) levels may vary widely based on the differences in their organic matter contents, and therefore, lime application should not be advocated merely on the basis of existing soil pH. Rather, proper testing of lime requirement is needed for the best results in terms of soil acidity amelioration and crop productivity improvement. Further, considering the importance of organic matter in determining the lime requirement of soils in study area, simple equations based on soil pH, target pH, and organic matter content may also be developed for easier estimation of lime requirement in the acidic soils of northeast India.

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REFERENCES

Aitken RL, Moody PW, Mckinley PG (1990). Lime requirement of acidic Queensland soils. I. Relationships between soil properties and pH buffer capacity. Aust J Soil Res 28: 695-701

Bouyoucos GJ (1962). Hydrometer method improved for making particle size analysis of soils. Agron J 54:464-465

Haynes RJ (1984). Lime and phosphate in the soil–plant system. Adv Agron 37: 249–315

Husni MHA, Devi S, Manas AR, Anuar AR, Shamshuddin J (1995). Chemical variables affecting the lime requirement determination of tropical peat soils. Commun Soil Sci Plan 26: 2111-2122

Keeney DR, Corey RB (1963). Factors affecting the lime requirements of Wisconsin soils. Soil Sci Soc Am J 27: 277-280

Mandal SC (1997). Introduction and historical overview. In: Mahapatra IC, Mandal SC, Misra C, Mitra GN, Panda N (eds) Acidic Soils of India (Eds.) ICAR, New Delhi, pp 3-24

Manoj-Kumar (2011). North East India: soil and water management imperatives for food security in a changing climate. Curr Sci 101: 1119

Pagani A, Mallarino AP (2012). Comparison of methods to determine crop lime requirement under field conditions. Soil Sci Soc Am J 76: 1855-1866

Patiram (1991). Liming of acid soils and crop production in Sikkim. J Hill Res 4: 6-12

Ross GJ, Lawton K, Ellis BG (1964). Lime requirement related to physical and chemical properties of nine Michigan soils. Soil Sci Soc Am J 28: 209-212

Sharma UC, Singh RP (2002). Acid soils of India: their distribution, management and future strategies for higher productivity. Fertilizer News 47: 45-52

Shoemaker HE, McLean EO, Pratt PF (1961). Buffer methods for determining lime requirement of soils with appreciable amounts of extractable aluminum. Soil Sci Soc Am Proc 25:274-277

Singh RK, Satapathy KK (2007). Scope and adoption of plasticulture technologies for enhancing production in north east hill region. Himalayan Ecol 15:14-21

von Uexkull HR, Mutert E (1995). Global extent, development and economic impact of acid soils. Plant Soil 171:1-15

Walkley A, Black IA (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci 37:29–38

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Leaf to Fruit Ratio Affects Fruit Yield and Quality of Low Chilling Peach Cv. Flordasun

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ABSTRACT

A study was conducted to standardize leaf to fruit ratio (LFR) during year 2011 and 2012 to observe its effect on fruit yield and quality of low chilling peach cv. Flordasun. All the LFR treatment advanced the harvest date by 4 to 11 days compared to control and earliest harvesting was recorded in 55:1 followed by 45:1 LFR. The fruit yield decreased linearly with increasing LFR and lowest yield was recorded in 55:1 LFR. The increase in LFR improved the fruit weight, fruit length, fruit diameter and pulp weight parameters were recorded highest in 55:1 followed by 45:1 LFR. While, pulp: stone ratio was recorded maximum in 45:1 followed by 35:1 and 55:1 LFR. Quality in terms of Total Soluble Sugar (TSS), ascorbic acid, total and reducing sugar were recorded highest in 55:1 followed by 45:1 LFR. On the other hand, lowest acidity and higher TSS: acid ratio was recorded in 45:1 followed by 35:1 and 55:1 LFR. Thus, 45:1 followed by 55:1 LFR were found suitable for cv. Flordsun under mid hill situation of north east India.

Keywords: Leaf to fruit ratio, Peach, Maturity, Yield, Fruit weight, Fruit quality.

INTRODUCTION

Peach (*Prunus persica* (L) Batsch.) is a potential fruit crop in terms of adaptability in India. It grows well at an altitude of 1000-2000 m above msl. Its commercial production is confined between 30° and 40° N and S latitudes. Introduction of early ripening low chilling peach cultivars paved the way for its commercial cultivation in non-traditional area. Among low chilling cultivars, Flordasun produces quality fruits under mid hill situation of northeast India particularly Meghalaya (Patel et al. 2007). But profuse bearing habit of cv. Flordasun, results in excessive crop load of undersized fruits with impaired fruit quality, limb breakage, exhaustion of tree reserves and reduce cold hardiness.

Peaches have a habit to set a large number of fruits under optimum growing condition and thereby reduce the possibility of getting commercial fruit size with quality fruit at harvest (Faust 1989; Costa and Vizzotto 2000; Southwick and Glozer 2000). Thinning practice is followed to adjust number of fruits per tree with high quality at harvest. Fruit size is dependent on the leaf to fruit ratio and their association with canopy size and bearing capacity (Westwood 1978). The indexes for estimating thinning amount were reported to be leaf to fruit ratio, total number of fruits per tree, fruit size and the distance between fruits within a branch (Mitra et al. 1991). In peach, end of fruit growth stage II (pit hardening) or beginning of stage III is the appropriate time for manual fruit thinning (Weinberger 1941). Fruit thinning by hand was found reliable way to improve fruit size (Costa and Vizzotto 2000) and quality fruits were obtained by hand-thinning of fruits at pit-hardening stage under Punjab conditions (Chanana et al.1998). But thinning response is closely related to type of cultivar, agro-climate, soil and other management practices. No information is available on appropriate thinning practice to be followed to maintain optimum leaf to fruit ratio in cv. Flordasun for quality fruit production under mid hills situation of North East India. Therefore, the aim of the present study was to observe the effects of leaf to fruit ratio on fruit yield and quality of low chilling peach cv. Flordasun.

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MATERIALS AND METHODS

The experiment was carried out for two years at ICAR Research Complex for NEH Region, Umiam, Meghalaya during the year 2011 and 2012. The experimental site is situated at an elevation of 900 meters abovemsl and lies between 25° 40' to 25° 21'N latitude and 90° 55'15 to 91°55'16 E longitude and comes under mid hill altitude. The climate of the site is sub temperate range of 5.4°C to 31.7°C and average annual rainfall of 2596.9 mm. The experimental material consisted of nine year old thirty six plants of cv. Flordasun, planted at a uniform distance of 4.5m under square system. The two trees per replication were selected based on their uniformity in size, vigor and crop load. The experiment was laid out in Randomized Block Design with three replication of six treatments viz., 15:1, 25:1, 35:1, 45:1 and 55:1 leaf to fruit ratio were carried out at pit hardening stage and an unthinned control. Fifty randomly selected fruits were sampled from each tree for fruit quality testing when fruit colour changed from green to yellowish. Observations recorded on fruit yield (kg/tree), fruit weight (g), fruit length (mm), fruit diameter (mm), fruit firmness (kg/cm^2), pulp weight (g), stone weight (g) and pulp:stone ratio (%). Fruit qualities in terms of total soluble solids (%), acidity (%), TSS: acid ratio, ascorbic acid (mg/100g), reducing sugar (%) and total sugars (%) were also recorded. TSS content was determined using a digital hand refractometer. Acidity was calculated by titrating fruit juice against 0.1 N/NaOH and expressed as malic acid. Ascorbic acid, reducing and total sugars were analysed according to Ranganna (2004). The data was statistically analysed and pooled results of two year was presented as per method of analysis of variance using RBD as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Harvest dates

The results (Table 1) showed earliness in harvest date of cv. Flordasun by 4-11 days compared with control in all leaf to fruit ratio (LFR) treatments imposed. The fruits of treatment 55:1 LFR (25th Apr) followed by 45:1 (26th Apr) were harvested earliest compared with others. These results are in line with Chananaet al. (2002) who reported that the thinning advanced the fruit maturity in peach.

Yield and fruit characteristics

Data (Table 1) showed the significant difference among the LFR treatments for yield and fruit characteristics in cv. Flordasun. The fruit yield decreased linearly with increasing LFR. The maximum fruit yield was recorded in control (31.42 kg/tree) while minimum in 55:1 LFR (17.54 kg/tree). However, the LFR 35:1 and 45:1 showed at par yield (22.96 and 21.33 kg/tree respectively). These results are in line with Chananaet al. (1998),Costa and Vizzotto (2000), Samuel and Goregory (2008) who reported that yield per tree decreased linearly with increasing spacing between fruits. The fruit weight showed increasing trend with LFR varied from 15:1 to 55:1. The highest fruit weight was recorded in treatment 55:1 LFR (49.21 g) followed by 45:1 (48.84 g) while lowest in control (39.28 g). Fruit size (length and diameter) is importantcommercial trait which influenced consumer preference. The fruit length and diameter was recorded significantly highest in treatment 55:1 LFR (48.21 mm and 47.62 mm,respectively) followed by 45:1 (47.56 mm and 46.77 mm, respectively) compared with all other treatments while, minimum in control (38.49 mm and 37.72 mm respectively). From the results, it was observed that 55:1 LFR produced highest pulp weight and stone weight (44.62 g and 4.11g respectively) followed by 45:1 (44.01 g and 4.03 g respectively). However, the maximum pulp to stone ratio was recorded in LFR of 45:1 (10.86%) followed by 35:1 (10.76%) and 55:1 (10.73%) and lowest in control (8.81%). The above results are in harmony with those obtained by Chanana et al. (1998) indicating that hand thinning increased the fruit weight in peach. Similarly, Samuel and Goregory (2008) also reported that fruit diameter decreased linearly with increasing spacing of peach.

The fruit firmness decreased linearly with increasing LFR. The unthinned (control) tree produced firm fruits (0.1462 kg/cm^2) followed by 15:1 and 25:1 LFR (0.1435 kg/cm^2 and 0.1412 kg/cm^2,respectively). However, minimum fruit firmness was recorded in 55:1 (0.1325 kg/cm^2) followed by 45:1 (0.1354 kg/cm^2). The result showed decreasing trend with increase in LFR. The reduction in fruit firmness might be due to larger fruit size that in tune decreases the strength of cell

Table 1: Effect of leaf to fruit ratio on yield and fruit characteristics of peach cv. Flordasun

Treatments	Date of harvest	Fruit yield (kg/tree)	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	Fruit firmness (kg/cm^2)	Pulp weight (g)	Stone weight (g)	Pulp : stone ratio
15:1	02-May	26.31	42.87	42.12	41.81	0.1435	38.41	3.77	10.19
25:1	01-May	24.37	46.10	45.06	44.22	0.1412	41.87	3.95	10.71
35:1	29-Apr	21.33	46.92	45.78	44.86	0.1389	42.94	3.86	10.76
45:1	26-Apr	20.12	48.84	47.56	46.77	0.1354	44.01	4.03	10.86
55:1	25- Apr	17.54	49.21	48.21	47.62	0.1325	44.62	4.11	10.73
Control	07-May	31.42	39.28	38.49	37.72	0.1462	34.86	3.99	8.81
SE m +		0.43	0.38	0.63	0.55	0.002	0.32	0.07	0.05
CD(P=0.05)		1.34	1.21	1.98	1.74	0.006	1.02	0.22	0.15

wall and lesser cohesion between the cells. These findings were in agreement with the findings of Saini and Kaunda (2003) in peach cv. Partap.

Fruit quality

The significant variation was observed among all the LFR treatments in respect of fruit quality. The result depicted in Table 2 revealed that the highest TSS was recorded in LFR of 55:1 (12.17%) followed by 45:1 (12.03%) and 35:1 (11.96%) showing at par values while, lowest in control (10.11%). However, lowest acidity and highest TSS: acid ratio were recorded in LFR of 45:1 (0.64% and 18.80, respectively) followed by 35:1 (0.67% and 17.85, respectively) and 55:1 (0.69% and 17.64, respectively). The ascorbic acid content was recorded highest in 55:1 (6.57 mg/100g) followed by 45:1 (6.34 mg/100g) while lowest in control (5.69 mg/100g). The sugars in terms of total and reducing sugar content were recorded highest in 55:1 (6.21% and 1.81% respectively) followed by 45:1 (6.13% and 1.79% respectively) and 35:1 (6.06% and 1.72% respectively). The improvement in quality traits of fruit might be due to reduced crop load due to thinning, resulting in more synthesis, transport and accumulation of nutrients in the remaining fruits. These results are in line with Saini and Kaunda (2003) and Chanana et al. (1998) who reported highest value for TSS and total sugar with hand thinning.

CONCLUSIONS

In light of the result obtained and discussed above, it could be concluded that 45:1 followed by 55:1 leaf to fruit ratio was optimum for improving fruit characteristics. Although control (unthinned) trees gave higher yield, the quality of such fruits was much inferior.

Table 2: Effect of leaf to fruit ratio on fruit quality of peach cv. Flordasun

Treatments	TSS (%)	Acidity (%)	TSS : acid ratio	Ascorbic acid (mg/100g)	Total sugars (%)	Reducing sugars (%)
15:1	11.25	0.76	14.80	5.78	5.82	1.61
25:1	11.58	0.72	16.08	5.91	6.00	1.65
35:1	11.96	0.67	17.85	6.14	6.06	1.72
45:1	12.03	0.64	18.80	6.34	6.13	1.79
55:1	12.17	0.69	17.64	6.57	6.21	1.81
Control	10.11	0.96	12.48	5.69	5.71	1.69
SE m +	0.07	0.01	0.09	0.10	0.05	0.01
CD(P=0.05)	0.21	0.05	0.28	0.31	0.15	0.03

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REFERENCES

ChananaYR, Kaundal GS, Kanwar JS, Arora NK, Saini RS (2002). Effect of chemical and hand thinning on maturity, yield and fruit quality of peaches (*Prunus persica* (L) Batsch.).ActaHort 592: 309-315

Chanana YR, Kaur B, Kaundal GS, Singh S (1998). Effect of flowers and fruit thinning on maturity, yield and quality in peach (*Prunus persica* Batsch). Indian Jof Horticulture 55 (4): 323-326

Costa G, Vizzotto G (2000). Fruit thinning of peach tree. Plant Growth Regul 31: 113-119

Faust M (1989). Physiology of temperate zone fruit trees.John Wiley & Sons, New York, USA

Mitra SK, Bose TK, Rathore DS (1991). Temperate Fruits.Horticulture and Allied Publishers, Calcutta, India

Panse VG, Sukhatme PV (1985). Statistical Methods for Agricultural Workers.4thed, ICAR, New Delhi

Patel RK, Babu KD, Singh A, Yadav DS (2007). Performance of low chilling peach cultivars under mid hills of Meghalaya. Environment & Ecology 25 (1): 229-231

Ranganna S (2004). Handbook of Analysis and Quality control for Fruits and Vegetable Products, 2nd ed., Tata McGraw, Hill Publishing Co. Ltd., New Delhi, India

Saini RS, Kaundal GS (2003). Effect of thinning treatments on pre and post storage behaviour of peach cv. Partap. Journal of Research 40 (1): 36-42

Samuel MC, Goregory LR (2008). Thinning time during stage I and fruit spacing influences fruit size of Contender' peach. Scientia Horticulture 115: 352-359

Southwick SM, Glozer K (2000). Reducing flowering with gibberellins to increase fruit size in stone fruit trees: applications and implications in fruit production. Hort Technology 10: 744-751

Weinberger JH (1941). Studies on time of peach thinning from blossoming to maturity. Proc Ame rSoc Hort Sci 38: 137-140

Westwood MN (1978). Temperate zone Pomology. San Franciso: WH Freeman and company, pp 119-219

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Liming and Integrated Nutrient Management for Enhancing Maize Productivity on Acidic Soils of Northeast India

Manoj-Kumar, S. Hazarika, B. U. Choudhury, T. Ramesh, B. C. Verma, L. J. Bordoloi

ABSTRACT

Lime application and integrated nutrient management is often recommended to increase the crop productivity on acidic soils. To ascertain the individual and synergistic effects of lime, NPK and farm yard manure (FYM) application on maize productivity, a field experiment was undertaken on an acid Alfisol (pH 4.6) of Meghalaya, Northeast India. Application of recommended NPK dose (80, 60 and 40 kg/ha of N, P_2O_5 and K_2O) resulted in 53% yield improvement, while liming @ 300 kg/ha (furrow application) caused 32 % yield increase over control. Combined application of NPK + lime resulted in 147% yield increase while application of FYM @ 5 t/ha along with NPK + lime further boosted the yield improvement up to 291% over control. Results of this study suggest that liming along with integrated nutrient management practices, if adopted properly, can lead to more than three-fold increase in maize productivity on acidic soils of Meghalaya and other north-eastern states of India with similar soils.

Keywords: Crop productivity, Lime application, North-eastern India, Soil acidity

INTRODUCTION

Soil acidity affects nearly 50 percent of the world's potentially arable land, particularly in humid tropics (von Uexkull and Mutert 1995). In India, approximately one-third of the cultivated land is affected by soil acidity (Mandal 1997). Majority of these soils are concentrated in north-eastern region of India, with nearly 65% of its area being under extreme forms of soil acidity (pH below 5.5) (Sharma and Singh 2002). Crop productivity on such soils is mostly constrained by aluminium (Al) and iron (Fe) toxicity, phosphorus (P) deficiency, low base saturation, impaired biological activity and other acidity-induced soil fertility and plant nutritional problems (Patiram 1991; Manoj-Kumar et al. 2012). The levels of soil acidity along with its associated impacts on soil fertility and crop productivity are expected to further intensify in a changing climate (Oh and Richter 2004; Manoj-Kumar 2011a&b). Soil acidity management and crop productivity improvement on such soils is therefore important for enhancing food security globally and regionally.

Meghalaya is an agriculturally important state in northeast India, with typically high levels of soil acidity and very high rainfall. Acidity–induced soil fertility problems coupled with traditionally minimal use of mineral fertilizers are often held responsible for low levels of crop productivity in the state. Lime application along with integrated nutrient management is often recommended to increase the phytoavailability of essential nutrients and ameliorate the other acidity-induced fertility constraints on such soils (Haynes 1984; Patiram 1991; Manoj-Kumar et al. 2012). It is therefore imperative to ascertain the yield benefits of individual as well as combined application of lime, chemical fertilisers and organic manure in a particular edapho-climatic condition. We evaluated the same in a field experiment (with maize as a test crop) on an acid Alfisol of Meghalaya, India. Additionally, we also evaluated the effectiveness of seed pelleting relative to furrow application of lime, either alone or in combination with other nutrient management practices.

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MATERIALS AND METHODS

A field experiment with maize (*Zea mays* L.) as test crop was undertaken on an acid Alfisol (pH 4.6) in research farm of Soil Science Division, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India. Selected physico-chemical properties of the experimental soil and the weather parameters prevailing during the crop growing months are shown in Table 1 and Fig. 1, respectively. Maize (var. RCM-75) was grown with 12 treatment combinations, each replicated thrice, and arranged in the Randomized Complete Block Design (individual plot size: 3x4 m^2). The treatments were as follows: T1: control; T2: 100% of recommended NPK dose (80, 60 and 40 kg/ha of N, P_2O_5 and K_2O); T3: liming (furrow application @ 300 kg/ha); T4: 100% NPK + liming (furrow application @ 300 kg/ha); T5: 100% NPK + Liming (furrow application @ 300 kg/ha) + FYM @ 5 t/ha; T6: lime coated seed (rice starch as sticking agent); T7: lime coated seed (rice starch) + 100% NPK; T8: lime coated seed (rice starch) + 100% NPK+ FYM @ 5 t/ha; T9: lime coated seed (gum arabic as sticking agent); T10: lime coated seed (gum arabic) + 100% NPK; T11: lime coated seed (gum arabic) + 100% NPK+ FYM @ 5 t/ha. N, P and K were applied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. Half of the N along with full doses of P and K was applied before sowing, while remaining half of the N was applied in two equal splits at 45 and 75 days after sowing. Lime was applied in furrows (Fig. 2) seven days before sowing and properly mixed with the soil. All recommended agronomic practices were followed during crop growth and the grain yield was recorded after harvesting the crop at maturity. Data were analyzed using the SPSS version 16.0 statistical package (SPSS Inc., Chicago, USA). Significance of the treatments' effect was considered at 0.05 probability level. The treatments' means were segregated using Duncan's Multiple Range Test.

Table 1: General physico-chemical properties of experimental soil

Soil properties	Values/description
Soil type	Typic Hapludalf
pH (1:2)	4.6
Sand (%)	52.7
Silt (%)	26.1
Clay (%)	21.2
Soil organic carbon (%)	1.02
Available N (kg/ha)	309
Available P (kg/ha)	23
Available K (kg/ha)	157

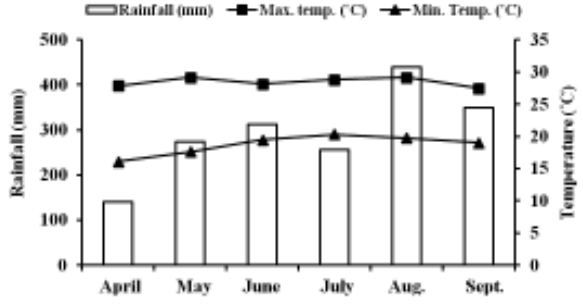

Fig. 1: Monthly distribution of rainfall and average temperature during crop growing season

Fig. 2: Furrow application of lime in the experimental plots

RESULTS AND DISCUSSION

Application of NPK, lime and FYM, either alone or in combination, had significant influences on the maize yield (Fig. 3). Application of recommended NPK dose resulted in 53.2% yield improvement and liming @ 300 kg/ha (furrow application) caused 32.4% yield increase over control. Combined application of NPK + lime resulted in 147% yield increase while application of FYM @ 5 t/ha along with NPK + lime further boosted the yield improvement up to 291% over control (Table 2). Our results are in conformity with the findings of Sharma et al. (2006) who, based on 141 experiments in farmers' field across the Assam and Meghalaya, reported 14-50% increase in yield of crops in response to lime application @ 2-4 q/ha, 22-100% yield increase by recommended dose of NPK application (i.e. 100% NPK), and 49-390% higher yield following combined use of NPK and lime compared to control (i.e. farmers' practice). Since

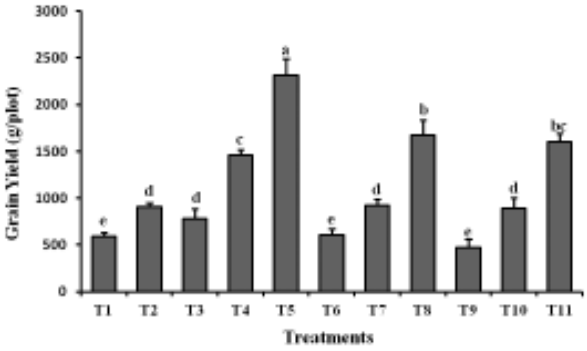

Fig. 3: Effect of liming and nutrient management practices on maize yield

Difference between values represented by bars having any common letter is statistically non-significant ($P<0.05$) and vice versa. (T1: control; T2: 100% of recommended NPK dose (80, 60 and 40 kg/ha of N, P_2O_5 and K_2O); T3: liming (furrow application @ 300 kg/ha); T4: 100% NPK + liming (furrow application @ 300 kg/ha); T5: 100% NPK + Liming (furrow application @ 300 kg/ha) + FYM @ 5 t/ha; T6: lime coated seed (rice starch as sticking agent); T7: lime coated seed (rice starch) + 100% NPK; T8: lime coated seed (rice starch) + 100% NPK+ FYM @ 5 t/ha; T9: lime coated seed (gum arabic as sticking agent); T10: lime coated seed (gum arabic) + 100% NPK; T11: lime coated seed (gum arabic) + 100% NPK+ FYM @ 5 t/ha).

the experimental soil was very strongly acidic in reaction (pH 4.6), the yield benefits from liming can be ascribed to the lime-induced increase in soil pH along with the associated improvement in nutrients' availability, reduced Al toxicity and many other attributes of soil fertility. Beneficial effects of NPK and FYM on maize yield can be understood given the fact that native NPK status of the experimental soil was in low to medium range. Seed coating with lime did not show any positive effect on crop yield. However, we suspect the low quality of liming material used for seed coating, which was obtained from the local market, might be the region behind this. Also, we might have failed to use the best possible concentration of sticking agent and coating techniques, leading to no improvement in maize yield by using the lime coated seeds. Thus we do not rule out the future possibility of this technique to be a potential technology in acidic soils; however, more research is required particularly for improving the seed coating techniques, which may lead to improved initial seedling establishment and subsequent crop yield.

Table 2: Comparative effects of liming and nutrient management practices on maize yield

Nutrient management practices	Percent increase in yield over control
Control	-
100% NPK (@ 80, 60 and 40 kg/ha of N, P_2O_5 and K_2O)	53.2
Liming (furrow application @ 300 kg/ha)	32.4
100% NPK + Liming	147
100% NPK + Liming + FYM (@ 5 t/ha)	291

To sum up, the results of this study suggest that liming along with integrated nutrient management practices, if adopted properly, can lead to more than three-fold increase in maize productivity on acidic soils of Meghalaya and other north-eastern states of India with similar soils.

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REFERENCES

Haynes RJ (1984). Lime and phosphate in the soil–plant system. Adv Agron 37: 249–315

Mandal SC (1997). Introduction and historical overview. In: Acidic Soils of India (Eds. Mahapatra IC, Mandal SC, Misra C, Mitra GN, Panda N.) ICAR, New Delhi, pp 3–24

Manoj-Kumar (2011a). North East India: soil and water management imperatives for food security in a changing climate. Curr Sci 101: 1119

Manoj-Kumar (2011b). Evidences, projections and potential impacts of climate change on food production in northeast India. Indian J Hill Farm 24(2): 1–10.

Manoj-Kumar, Khan MH, Singh P, Ngachan SV, Rajkhowa DJ, Kumar A, Devi MH (2012). Variable lime requirement based on differences in organic matter content of iso-acidic soils. Indian J Hill Farm 25(1):26-30

Oh N-H, Richter DD (2004). Soil acidification induced by elevated atmospheric CO_2. Global Change Biol 10: 1936–1946

Patiram (1991). Liming of acid soils and crop production in Sikkim. J Hill Res 4: 6–12

Sharma UC, Singh RP (2002). Acid soils of India: their distribution, management and future strategies for higher productivity. Fertilizer News 47: 45–52

Sharma PD, Baruah TC, Maji AK, Patiram (2006). Management of acid soils in NEH Region, Natural Resource Management Division (ICAR), Krishi Anusandhan Bhawan-II, Pusa Campus, New Delhi. Technical Bulletin, pp 14

von Uexkull HR, Mutert E (1995). Global extent, development and economic impact of acid soils. Plant Soil 171:1–15

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Microsatellite Markers Revealed Genetic Diversity in Mungbean Mutant Lines

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ABSTRACT

Estimation of genetic diversity in a crop species is prerequisite for its improvement. DNA markers provide an opportunity to characterize genotypes and to measure genetic relationships precisely than other markers. Microsatellite markers are among the most popular genetic markers due to their characteristic features like high polymorphism, co-dominance, abundant informativeness, convenience of assay by PCR and distribution throughout the genome. The use of germplasm with distinct DNA profiles helps to generate breeding populations with broad genetic base. In the present study, SSR markers were used to analyze the genetic diversity of 30 mutant lines along with its parent PUSA-9072. A total of 8 primers were used for STMS analyses and 9 alleles were generated and the number of alleles per SSR primer ranged from 1 to 2 with an average of 1.15 per primer. The size of the amplification products varied in case of each primer and the range was 50bp to 250 bp. The dendrogram constructed based on SSR data using average linkage, grouped the mutant lines into two different clusters having all the mutants in one cluster and the parent in other. Clustering pattern based on SSR marker data indicated that there is a narrow genetic base of mungbean mutant lines. The absence of polymorphism indicates that the mutation were not on the tandem repeat region. The results indicate the usefulness of SSR in the assessment of genetic diversity in plants.

Keywords: Genetic diversity, SSR, Mungbean, Microsatellites, STMS

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops, it is also known as greengram and is the most widely distributed among the six Asiatic *Vigna* species. Improvement of the cultivated plants largely depends on the extent of genetic variability available within the species. Besides natural genetic variation, mutagenesis is a potent device in creating variability and in obtaining novel traits (Sangsiri et al. 2005). Many mutants have made transitional impact on increasing yield and quality of several seed propagated crops (Ahloowalia et al. 2004). The mungbean variety, Pusa 9072 was treated ethyl methane sulphonate (EMS) and selected mutant lines were advanced to M_8 generation. Therefore, in the present study, an attempt has been made to study the induced variation among 30 mutant lines and parent genotype (Pusa 9072).

Conventionally, genetic diversity is estimated by morphological observations recorded on quantitative traits based on multivariate analysis, a potent tool in quantifying the degree of divergence in evaluation of germplasm collection of various crops. However, the results of such studies pertaining to genetic diversity are inconsistent; relevant only for genotypes used and environment involved in a particular study and cannot be generalized. Therefore, studies on above aspects on the available germplasm under specified environment where it is to be explained are essential for successful utilization of germplasm resources for the development of superior varieties.

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Advances in molecular biology have introduced an alternative for variety/genotype identification. The genetic characterization of germplasm helps in their effective conservation and reveals the extent of relationship among the accessions and the estimates of genetic diversity. The DNA of different individuals is tested for their similarity and dissimilarity at particular locus. Among the molecular markers, microsatellite markers are hyper-variable, co-dominant and highly reproducible, making them ideal for genome mapping (Jena et al. 2005), genetic diversity analysis (Brondani et al. 2005), varietal identification (Li et al. 2000), parentage analysis (Li et al. 2000; Yashitola et al. 2004), identification of heterozygotes and true hybridity (Nandakumar et al. 2004) and tagging and mapping of important traits (Sun et al. 2005). The most important uses of STMS markers are tagging gene for economic traits and for the study of genetic diversity.

MATERIALS AND METHODS

The mungbean genotype, Pusa 9072 was treated with a chemical mutagen, ethyl methane sulphonate (EMS) and 30 selected mungbean mutant lines were advanced to M_8 generation.

Extraction and purification of genomic DNA

The seeds of mungbean were sown in pots and kept in green house. After 8-10 days when the seedlings attained around 5-6 inches height, 15 plants were pooled and used for DNA isolation. Genomic DNA was isolated from mungbean seedlings using CTAB method (Saghai-Maroof et al. 1984) with minor modifications. Fresh and healthy seedlings were selected and frozen in liquid nitrogen and then crushed to fine powder using mortar and pestle. The fine powdered material was transferred to a preheated extraction buffer (20ml) in centrifuge tube. These mixtures were vortexed well and incubated in water bath at 600C for one hour with intermittent shaking. After incubation, equal amount of chloroform: isoamyl alcohol (24:1) was added to the centrifuge tube. Gently mixed the mixture and then centrifuged at 17000 rpm for 10 minutes in Sorval RC centrifuge at 25°C. The mixture was separated into two layers, *viz.* upper aqueous layer and lower organic layer after centrifugation. The aqueous layer was transferred into fresh centrifuge tube and DNA was precipitated by adding the equal amount of isopropanol or propanol. DNA was spooled out carefully with the help of dropper or wide bore tips and chemical was drained out. The precipitated DNA was transferred into 2ml eppendorf and washed 2-3 times with 70% alcohol. After washing the DNA was dried in vaccum drier. Dry DNA pellet was dissolved in minimum volume of Tris-EDTA (TE) buffer (10:1).

Extracted DNA were treated with RNase A (20mg/ml) at a concentration of 40 µl/ml of DNA and kept for incubation at 37°C for one hour. Protein k was added after one hour and kept for incubation again at 37°C for one hour. An equal amount of phenol: chloroform: isoamyl alcohol (25:24:1) was added after one hour to the solution and mixed by swirling for five minutes. After mixing, the solution was centrifuged at 10000 rpm for 5 minutes and upper aqueous layer was removed and transferred into fresh eppendorf tube. This process was repeated twice and DNA was precipitated by adding 1/10 volume of 3M sodium acetate (pH 6.5) and 2.5 times (v/v) chilled ethanol. Extra salt was removed by further washing with 70% ethanol and DNA was dried under vaccum. The dried DNA pellet was dissolved in T:E (10:1) buffer at room temperature and stored at 4°C.

Dilution of DNA

Purified and extracted DNA concentration was estimated using Hoefer DYNA Quant 200 Fluorimeter (Hoefer Scientific San Fransisco, USA) using Hoechst 33258 (Bisbenzamide) as the florescent dye and calf thymus DNA as the standard (Brunk et al. 1979). A part of DNA sample was diluted with appropriate amount of T:E (10:1) pH 8.0 to yield a working concentration of 20 ng/µl and stored at -20ºC.

Sequence Tagged Microsatellite Site analysis

Optimization of PCR component concentration was carried out for Taq DNA polymerase, $MgCl_2$, genomic DNA and primer. Concentration of dNTPs and 10X PCR buffer was not varied. PCR was carried out in a DNA thermal cycler (Gene Amp 9600 PCR system, Perkin Elmer Cetus Norwalk, CT, USA). The thermocycling conditions in PCR for microsatellite analysis were as follows, Denaturation for 94°C for 6 minutes, 30 cycles of denaturation at 94°C for 1 minute, primer annealing at respective annealing temperature for 1 minute

and primer extension at 72°C for 1 minute, final extension step at 72°C for 10 minutes and at 4°C till end.

A total of eight primers were selected for STMS analysis. The detail of used primers along with their sequences is given in table 1. The annealing temperature was standardized according to Tm of primer. Amplification reaction was performed in a final volume of 25 µl, consisting 1X reaction buffer (10mM HCL, pH 8.3, 50mm KCL), 0.25 µM of each primer, 2.0 mM MgSO4, 1U Ampli Taq DNA Polymerase, 60ng genomic DNA and 200 µM of each of dATP, dGTP, dCTP and dTTP. All the PCR amplification was done on 0.2ml Axygen thin walled PCR tubes. These tubes contain the above product were capped and spun at 15000 rpm for 2 seconds to allow proper settling of reaction mixture.

Table 1: List and Sequence of microsatellite markers used in the present study

Sl. No.	Primer	Primer sequence (5'-3')	Repeat Unit	Annealing temp.
1.	AB128079	AGGCGAGGTTTCGTTTCAAG	(AG)	55°C
		GCCCATATTTTTACGCCCAC		
2.	AB128093	CCCGATGAACGCTAATGCTG	(AG)	53°C
		CGCCAAAGGAAACGCAGAAC		
3.	AB128113	TCAGCAATCACTCATGTGGG	(AG)	55°C
		TGGGACAAACCTCATGGTTG		
4.	AB128135	AGGATTGTGGTTGGTGCATG	(AG)	55°C
		ACTATTTCCAACCTGCTGGG		
5.	VM22	GCGGGTAGTGTATACAATTTG	(AG)	52°C
		GTACTGTTCCATGGAAGATCT		
6.	VM24	TCAACAACACCTAGGAGCCAA	(AG)	48°C
		ATCGTGACCTAGTGCCCACC		
7.	VM31	CGCTCTTCGTTGATGGTTATG	(CT)	48°C
		GTGTTCTAGAGGGTGTGATGGT		
8.	MB122A	TGGTTGGTTGGTTCACAAGA	(TGGT)	48°C
		CACGGGTTCTGTCTCCAATA		

Gel electrophoresis

After completing the PCR amplification 2.0 µl of 6X loading dye (MBI Fermentas), was added. Mix the loading dye with PCR component and spun at 5000 rpm for 1 minute. Agarose (3.4%) gel in 1X TBE buffer with 10 µl ethidium bromide per 100 ml of gel volume was prepared. Electrophoresis was carried out at 50 volts for 2 hours. The gel was imaged with gel documentation system.

Data scoring and statistical analysis

Each amplification product was considered a DNA marker and was scored across all samples. The data on microsatellite were scored manually for the presence (1) and absence (0) of bands. Very faint bands were not considered for final scoring. The band sizes were estimated using 50bp to 1kb DNA molecular weight markers (MBI Fermentas). The data set of mutants and reproducible bands were used to calculate pair-wise similarity coefficients following Jaccard (1908). The matrix of similarity coefficients was subjected to unweighted pair-group analysis (UPGMA) to generate a dendrograms using average linkage procedure. The binary data were analysed using Free tree software.

RESULTS AND DISCUSSIONS

Mutation breeding is relatively quicker method for improvement of crops. Many physical and chemical mutagens have been used for induction of useful mutants in number of crops. However, the variability so induced may be in positive or negative direction. Genetic markers can be used to portray diversity within the cultivated germplasm and to identify grouping of cultivars which are adapted to particular regions (Paterson et al. 1991b). Earlier, assessment of genetic diversity has traditionally been made through morphological characters, which are often limited in number, have complex inheritance and vulnerable to environmental conditions. In present study, diversity induced through chemical mutagen (EMS) was studied in M_8 generation using SSR markers.

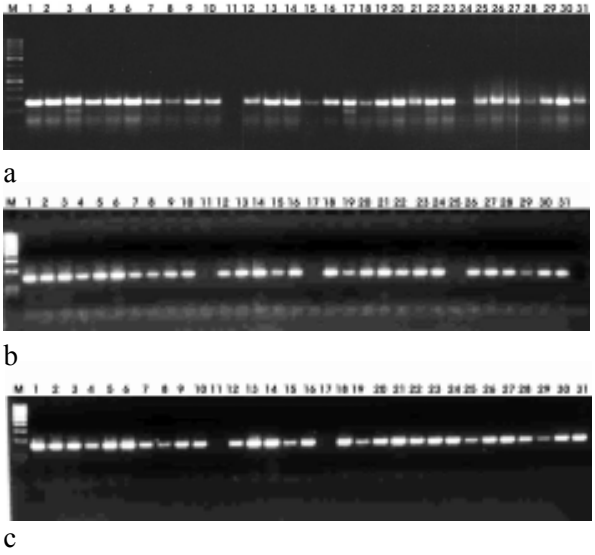
A total of 8 primers were used for STMS analyses and 9 alleles were generated and the number of alleles per SSR primer ranged from 1 to 2 with an average of 1.15 per primer (Table 2). Yu et al. (1999) reported the abundance and variation

Table 2: Characteristics of STMS amplification products generated by the eight STMS primer pairs in the mungbean mutants analysed

Sl. No.	STMS Primers	Total no of bands	No. of polymorphic bands	No. of banding pattern
1.	AB128079	01	00	01
2.	AB128093	01	00	01
3.	AB128113	01	00	01
4.	AB128135	01	00	01
5.	VM22	01	00	01
6.	VM24	01	00	01
7.	VM31	01	00	01
8.	MB122A	02	02	02

of microsatellite DNA sequences in *Phaseolus* and *Vigna* spp. Nasiri et al. (2009) has studied diversity in 77 genotypes of pea using 10 microsatellite markers and detected 59 alleles and number of alleles per locus varied from 2 to 8, with a mean of 5.9 alleles per locus. SSR markers are also utilized to decipher diversity in non legume crops like sorghum. Rajarajan and Ganesamurthy (2011) carried out genetic diversity analysis in 100 sorghum genotypes for drought tolerance using 13 stay-green specific polymorphic SSR markers which revealed high level of polymorphism among the genotypes, about 56 scorable alleles were generated, of which 55 were polymorphic and the number of alleles produced by different primers ranged from 2 to 7 with an average of 4.0 alleles per primer. However, Reddy et al. (2008) reported that accessions with most distinct DNA profiles are likely to contain the greatest number of novel alleles. It is these accessions that are likely to uncover the largest number of unique and potentially agronomic useful alleles.

The size of the amplification products varied in case of each primer and the range was 50bp to 250 bp. Fig. 1 is representative of the extent of polymorphism observed through STMS markers among the mutants. The numbers of banding pattern among the primers were also varied from 1 to 2. Cluster analysis of the distribution of STMS bands



a

b

c

Fig. 1: Banding pattern of mutant lines and parent revealed by SSR primer (a) AB128079, (b) AB128113 (c) AB128135. Lane M is standard marker 50 bp. Lane 1 to 30 mutant lines (AAIMM-1 to AAIMM-30) lane 31 is parent (Pusa 9072).

have been represented as a dendrogram using average linkage (Fig. 2). Similarity coefficient ranged for parent and mutants from 0.7778 to 1, while the mean value for parent was 0.7849 and for mutants 0.9857 (Table 3). The results of Xiao et al. (1996) involving crosses between four japonica and six indica elite inbred rice lines that are widely used in Chinese breeding programs, have indicated that genetic distance measures based on RAPDs and SSRs could be useful for predicting yield potential.

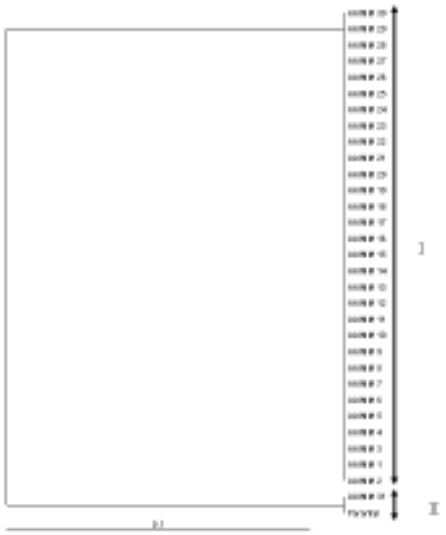


Fig. 2: Dendrogram revealed by UPGMA cluster analysis for 31 mutant lines and parent (Pusa-9072) based on STMS analysis

The dendrogram constructed based on SSR data using average linkage, mungbean mutants developed from chemical mutagenic treatment were grouped into two different clusters (Fig. 2). The cluster I consisted AAIMM-30, AAIMM-29, AAIMM-28, AAIMM-27, AAIMM-26, AAIMM-25, AAIMM-24, AAIMM-23, AAIMM-22, AAIMM-21, AAIMM-21, AAIMM-20, AAIMM-19, AAIMM-18, AAIMM-17, AAIMM-16, AAIMM-15, AAIMM-14, AAIMM-13, AAIMM-12, AAIMM-11, AAIMM-10, AAIMM-9, AAIMM-8, AAIMM-7, AAIMM-6, AAIMM-5, AAIMM-4, AAIMM-3, AAIMM-1 and AAIMM-2, while parent line AAIMM-31 was found in cluster II. Clustering pattern based on SSR marker data indicated that there is a narrow genetic base of mungbean mutant lines. Dikshit et al. (2007) found SSR marker was more efficient in detecting genetic variability among all *Vigna* species. But in the case

Table 3: Simple matching coefficients between the genotypes analysed based on STMS analysis

Mutant Lines	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.00															
2	1	1.00														
3	1	1	1.00													
4	1	1	1	1.00												
5	1	1	1	1	1.00											
6	1	1	1	1	1	1.00										
7	1	1	1	1	1	1	1.00									
8	1	1	1	1	1	1	1	1.00								
9	1	1	1	1	1	1	1	1	1.00							
10	1	1	1	1	1	1	1	1	1	1.00						
11	1	1	1	1	1	1	1	1	1	1	1.00					
12	1	1	1	1	1	1	1	1	1	1	1	1.00				
13	1	1	1	1	1	1	1	1	1	1	1	1	1.00			
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00		
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00	
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31 Parent	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778

*AAIMM-1 to AAIMM-31 are designated 1 to 31

Mutant Lines	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Parent
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17	1.00														
18	1	1.00													
19	1	1	1.00												
20	1	1	1	1.00											
21	1	1	1	1	1.00										
22	1	1	1	1	1	1.00									
23	1	1	1	1	1	1	1.00								
24	1	1	1	1	1	1	1	1.00							
25	1	1	1	1	1	1	1	1	1.00						
26	1	1	1	1	1	1	1	1	1	1.00					
27	1	1	1	1	1	1	1	1	1	1	1.00				
28	1	1	1	1	1	1	1	1	1	1	1	1.00			
29	1	1	1	1	1	1	1	1	1	1	1	1	1.00		
30	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00	
31 Parent	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	0.7778	1.00

of narrow genetic base of the *V. radiata* cultivars obtained a lower level of polymorphism in comparison to the RAPD and ISSR markers in mutants because the STMS markers are locus specific marker. The microsatellite markers are rapidly becoming a preferred type of DNA marker used for germplasm analysis and varietal identification, marker assisted selection and

genome mapping because it is locus specific marker but in the case of mutants' identification, very less variation was observed in the profile of mutants. Polymorphism is due to mutations in both the SSR region and the flanking regions contributing to the variation in allele size and number among different mutants.

CONCLUSIONS

The absence of polymorphism indicates that the mutations were not on the tandem repeat region. The SSR primer MB122A was identified as the best primer for mutant analysis and the SSR markers could be well utilized to analyze the mutants at DNA level.

REFERENCES

Ahloowalia BS, Maluszynski M, Nichterlein K (2004). Global impact of mutation-derived varieties. Euphytica 135: 187-204

Brondani RP, Zucchi MI, Brondani C, Rangel PH, Oliveira Borda TC, Rangel PN, Magalhaes MR, Vencovsky R (2005). Genetic structure of wild rice Oryza gluaepatula populations in three Brazilian biomes using microsatellite markers. Genetica 125 (2-3): 115-123

Brunk CF, Jones KC, James TW (1979). Assay for nano-gram quantities of DNA in cellular homogenates. Analytical Biochemistry 92: 497-500

Dikshit, HK, Juang T, Singh NK, Kondal KR, Bansal KC, Chandra N, Tickoo JL and Sharma TR (2007). Genetic differentiation of Vigna species by RAPD, URP and SSR markers. Biologia Plantarum 51(3): 451-457

Jaccard P (1908). Nouvelles rescerches, sur la distribution florale. Bull Soc Vaud Sci Natl 44: 233-270

Jena KK, Jeung JU, Lee JH, Choi HC, and Brar DS. 2005. High-resolution mapping of a new brown plant hopper resistance gene, Bph18 (t), and marker-assisted selection for BPH resistance in rice (Oryza sativa L.). Theoretical and Applied Genetics 21: 1-10

Li JZ, He P, Li SG, Lu RL, Zhu LH (2000). Application of microsatellite markers for the seed purity examination of hybrid rice, Gangyou-22. Sheng Wu Gong Cheng xue Bao 16(2): 211-214

Nandakumar N, Singh AK, Sharma RK, Mohapatra T, Prabhu KV, Zaman FU (2004). Molecular fingerprinting of hybrids and assessment of genetic purity of hybrid seeds in rice using microsatellite markers. Euphytica 136(3): 257-264

Nasiri J, Shaghnazari A, Saba J (2009). Genetic diversity among varieties and wild species accessions of pea (*Pisum sativum* L.) based on SSR markers. African Journal of Biotechnology 8(15): 3405-3417

Paterson AH, Damon S, Hewitt JD, Zamir D, Rabinowitch HD, Lincoln SE, Lander SE, Tanksley SD (1991). Mendelian factors underlying quantitative traits in tomato: comparison across species, generations and environments. Genetics 127: 181-197

Rajarajan K, Ganesamurthy K (2011). Genetic diversity analysis of sorghum [*Sorghum bicolour* (L.) Moench] genoty.pes for drought tolerance using SSR markers. Indian Journal of Genetics 71(1): 17-24

Reddy KS, Souframanien J, Reddy KS, Dhanasekar P (2008). Genetic diversity in mungbean as revealed by SSR and ISSR markers. Journal of Food Legumes 21(1): 15-21

Saghai-Maroof MA, Soliman KM, Jorgensen RA, Allard RW (1984). Ribosomal DNA spacer length polymorphism in barley: Mendelian inheritance, chromosomal location and population dynamics. Proceedings of National Academy of Sciences USA 83: 1757-1761

Sangsiri C, Sorajjapinun W, Srinivas P (2005). Gamma Radiation Induced Mutations in Mungbean Sci Asia 31: 251-255

Sun L, Su C, Zhai H, Wan J (2005). Mapping of a major resistance gene to the brown plant hopper in the rice cultivar raathu heenati. Breeding Science 55(4): 391-396

Xaio J, Li J, Yuan L, McCouch SR, Tanksley SD (1996). Genetic diversity and its relationship to hybrid performance heterosis in rice revealed by PCR-based markers. Theoretical and Applied Genetics 92: 637-643

Yashitola J, Sundaram RM, Biradar SK, Thirumurugan T, Vishnupriya MR, Rajeshwari R, Viraktamah BC, Sarma NP, Sonti RV (2004). A sequence specific PCR marker for distinguishing rice lines on the basis of Wild Abortive Cytoplasm from their cognate maintainer lines. Crop Science 44: 920-924

Yu K, Park SJ, Poysa V (1999). Abundance and variation of microsatellite DNA sequences in beans (*Phaseolus* and *Vigna*). Genome 42: 27-34

Indian Journal of Hill Farming 25(1):44-47 Available online at www.kiran.nic.in

Comparative Growth Performance of Deccani Lambs Under Various Rearing Systems in Agro-ecological Conditions of Konkan

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ABSTRACT

The experiment was carried out during winter season (Dec-March) to study comparative growth performance of Deccani lambs under different rearing systems. Twelve Deccani lambs of 3 months age were randomly allocated into three groups of four lambs each *viz*., T_1 (Grazing), T_2 (Semistallfed), T_3 (Stallfed). T_1 lambs were maintained on 6-7 hrs grazing (100%) with supplementation of concentrate mixture at night as maintenance ration. Both T_2 and T_3 lambs were reared on green roughages of green maize (*Zea mays*) and Shivan (*Gmelina arborea*) tree leaves with concentrate mixtures for maintenance. The dry matter intake, average daily gain in body weight, body length, body height, chest girth and total greasy fleece yield was significantly higher ($P< 0.01$) in stallfed system than grazing and semistallfed systems. The higher intake of dry matter in T_3 (Stallfed) lambs was observed than the lambs reared under the other two systems. Considering superior growth performance of Deccani lambs under stallfed system,present study concludes that , the sustainable lamb production could be promoted in stallfed (Intensive) system in Konkan region of Central India.

Keywords: Sheep, Housing system, Growth performance, Greasy fleece yield

INTRODUCTION

The central part of India has a much diversified climate. Majority of the area in this part falls under rainfed agriculture; hence there is a serious problem of uniform supply of fodder to the farm animal throughout the year. The sheep rearing has multiutility value and plays an important role in national economy. Sheep graze close to the ground so they are called as weed killers or ground cleaners, and also have a high digestibility. There is thus large scope in this farming for employment opportunities for skilled workers along with landless labours. Therefore, sheep farming is widely considered as one of the poverty elevating enterprise (Dastagiri and Rao 1990).

In Konkan region of India, sheep rearing is not practical on a large scale due to high rainfall and humidity conditions. However, it is observed that the shepherds migrate from upghat areas to Konkan region for grazing of sheep on natural pastures and stubbles in the field of paddy harvested crops. This indicates that profitable sheep rearing could be possible in this region, provided due care is taken especially during rainy season. Therefore, present investigation was carried out to study the growth performance and economics of sheep rearing under three different rearing systems in Konkan region of India.

MATERIALS AND METHODS

The experiment was carried out during winter December 2008 to March 2009 in experimental farms of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (Dist. Ratnagiri); Maharashtra. The study was conducted on twelve (3 month old) Deccani lambs weighing between 14 to 16 kg. The lambs were housed in grazing, semistall and stallfed systems of rearing. The lambs were provided with good quality drinking water. Prophylatic measures against sheep diseases like sheep pox, ticks mites, lice, endo and ectoparasitic infestations were carried out. Further, the lambs were randomly allocated into three groups of four Deccani lambs (3 months of age) each namely, T_1 (grazing), T_2 (semi stallfed) and T_3 (stallfed) systems. Care was taken while grouping the animals to ensure that lambs were even aged and there were no significant

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changes between groups on average body weight before start of the experiment. T_1 group (grazing) was maintained purely (100%) on grazing for 6-7 hrs on surrounding hortipastoral areas. The T_2 lambs (semi stallfed) were maintained on grazing (50%) and stall-fed (50%) conditions with supplementation of concentrate mixtures for maintenance. T_3 lambs (stallfed) were completely maintained in the shed with green maize (*Zea mays*) harvested at flowering stage used as green roughages and jowar kadbi as dry roughages. Shivan (*Gmelina arborea*) tree leaves were also provided as green roughages for T_2 (semistallfed) and T_3 (stalled) systems. The concentrate mixture was provided to the lambs under three systems in afternoon and evening for maintenance ration. The quantity of concentrate mixture was calculated at the rate of one third of the total dry matter required for their body weight.

The observations were recorded at weekly intervals for body weight of lambs, fortnightly for body length, body height and chest girth. The left over quantity of roughages and concentrate mixture were measured the next morning to get actual intake of feeds and only concentrate mixture for T_1 (grazing). The dry matter intake was calculated with help of actual intake of feeds and concentrate mixture was multiplied by the dry matter content of feeds offered in all three systems. The average greasy fleece weight was calculated in grazing, semistallfed and stallfed system after lambs attained six months of age i.e. slaughter age. The feed cost per kg gain in body weight under three systems was worked out, considering the current prices.

All the data were subjected to statistical analysis by using one way ANOVA. Statistical software SPSS 13.0 for windows (SPSS Inc. 2004) was used for overall statistical analysis. Differences between treatments were analyzed using ANOVA at a significance level of 0.05. Afterwards, Tukey HSD (Tukey's Honestly Significant Difference) test was used to find out the significant differences between mean values.

RESULTS AND DISCUSSION

Overall results are presented in Table 1. The total dry matter intake per day per lamb was found to be 573.27 + 10.25 g for grazing, 676.07+38.76 g for semistallfed and 710.35+ 31.19 g for stallfed systems. The average dry matter intake per day per lamb was significantly higher ($P< 0.01$) in stallfed system than others. The dry matter intake per 100 kg body weight was observed to be maximum in stallfed system (3.86 + 0.156 kg.) followed by semistallfed (3.41 + 0.192 kg) and grazing (2.94 + 0.056 kg) system. Our results are in conformities with the results obtained by Krishnamohan and Naidu (1984) and Solanki (1990).

Table 1. Growth performance of Deccani lambs under different management systems

Parameters	Grazing	Semi-stallfed	Stallfed
Initial body weight (kg)	15.0 ± 1.64	14.92 ± 0.63	14.95 ± 1.17
Final body weight (kg)	17.02 ± 1.44	17.52 ± 0.62	18.40 ± 0.41
Total gain in body weight (kg)	2.02 ± 0.265^{bC}	2.02 ± 0.117^{ab}	3.45 ± 0.81^{a}
ADG in Body weight (g/day lamb)	22.50 ± 2.95^{b}	28.89 ± 1.30^{ab}	38.33 ± 8.99^{a}
Dry Matter Intake (g)	573.27 ±10.25^{b}	676.07 ± 38.76^{ab}	710.35 ± 31.19^{a}
Dry Matter Intake (g), % Body weight (kg)	2.94 ± 0.056^{b}	3.41 ± 0.92^{ab}	3.86 ± 0.156^{a}
Body Measurement	8.77	9.07	9.92
Body length (cm)	± 0.32^{b}	± 0.56^{ab}	± 0.60^{a}
ADG in body length (cm/day/lamb)	0.097 ± 0.004^{b}	0.1008 ± 0.006^{ab}	0.11 ± 0.007^{a}
Withers height (cm)	8.90 ± 0.203^{b}	9.40 ± 0.26^{ab}	9.57 ± 0.25^{a}
ADG in height (cm/day/lamb)	0.099 ± 0.002^{b}	0.104 ± 0.003^{ab}	0.106 ± 0.003^{a}
Chest girth (cm)	9.15 ± 0.28^{b}	10.15 ± 0.31^{ab}	10.30 ± 0.127^{a}
ADG in chest girth (cm/day/lamb)	0.102 ± 0.009^{b}	0.113 ± 0.004^{ab}	0.114 ± 0.001^{a}
Total greasy fleece yield (kg)	0.924 ± 0.003^{b}	1.335 ± 0.005^{ab}	1.349 ± 0.002^{a}
Average greasy fleece yield (kg/lamb)	0.231 ± 0.0095^{b}	0.333 ± 0.039^{ab}	0.337 ± 0.040^{a}

Note: Different small letter after mean values indicate significant difference among rearing systems (Tukey's HSD, $P<0.05$), ADG=Average Daily Gain

The average total body weight gain in 90 days was higher in stallfed system (3.45 + 0.81 kg/lamb) than semistall system (2.6 +0.117 kg/lamb) and grazing system (2.025 + 0.265/lamb). The average daily gain in weight per lamb was significantly higher ($P< 0.01$) in stallfed (38.33 + 8.99 g) than the semistallfed (28.89 + 1.30 g) and grazing system (22.5 + 2.95 g).. The results of this study were in

agreement with findings of Johri and Talpatra (1997), Saini et al. (1986) and Jagtap and Naikare (1989).

The average total body length gain during experimental period was maximum in stallfed lambs (9.92 + 0.601 cm) followed by semistallfed lambs (9.07 + 0.566 cm) and grazing lambs (8.77 + 0.32 cm) [Table 1.]. The average daily gain in body length per lamb was significantly higher ($P < 0.01$) in stallfed system (0.11 + 0.007 cm) than the semistallfed (0.1008 +0.006 cm) and grazing system (0.097 + 0.004 cm) (Table 1). The average body length gain of lambs in present study is similar to the growth performance of sheep as earlier findings of Dass (2007).

The average body height was found maximum in stallfed system (9.57 + 0.25 cm) followed by semistallfed (9.4 + 0.26 cm) and grazing (8.9+0.203 cm). Present study revealed that the average daily gain in body height per lambs were significantly higher ($P< 0.01$) in stallfed lambs (0.106 + 0.003 cm) than semistallfed (0.104 + 0.003 cm) and grazing (0.099 + 0.002 cm).The findings of Mali et al.(1985) revealed that Deccani sheep showed similar types of body measurements during the growth period of sheep.

The present study showed that the average total gain in chest girth of 9.15 + 0.28 cm, 10.15 + 0.31 cm and 10.30 + 0.127 cm were observed in grazing, semistallfed and stallfed systems, respectively. The average daily gain in chest girth per lamb was significantly higher ($P < 0.01$) in stallfed (0.114 + 0.001 cm) than semistallfed (0.113 +0.004) and grazing (0.102+0.003 cm). The relationship of body measurements like body length, height, chest girth of Deccani sheep was also observed by Mali et al. (1985).

The average total greasy fleece yield during experimental period (lambs attained slaughter age) was higher in stallfed system (1.349 + 0.002 kg) than semistallfed (1.335 + 0.005 kg) and grazing (0.924 + 0.003 kg) system. The average greasy fleece yield per lamb was significantly higher ($P < 0.01$ in stallfed lambs (0.337 + 0.040 kg) than semistallfed (0.333 + 0.039 kg) and grazing system (0.231 + 0.0095 kg). This effect of body weight and wool production in Deccani and crossbred sheep were observed by Thorat et al. (1990).Therefore the greasy fleece production was more in Deccani lambs reared in stallfed system.

The cost per unit live weight gain in different management systems are tabulated in Table.2. It is observed that the total cost of feed per lamb per day was Rs. 1.43 in grazing, Rs. 2.63 in semistallfed and Rs. 4.11 in stallfed systems. The data pertinently showed that feed cost per kg live weight gain was Rs. 0.70, 1.00 and 1.19 per lamb per day in grazing, semistallfed and stallfed systems, respectively.The results revealed that stallfeeding is more economical than the grazing and semistall feeding considering feed cost/kg live gain in weight. In the present findings, the feed cost/kg live weight gain was more economical than the other two systems. Similar results obtained by Singh et al. (1986) also proved that sheep reared under stallfed was more beneficial considering feed cost/live weight gain during the growing period of Chokla and Merino sheep.

Table 2: Cost per unit live weight gain in different management systems

Particulars	Grazing	Semi-stallfed	Stallfed
Total Experimental Period	90 days	90 days	90 days
Initial body weight (kg)	15.00	14.92	14.95
Final body weight(kg)	17.02	17.52	18.40
Total weight gain (kg)	2.02	2.60	3.45
Average daily gain in weight (g)	22.50	28.89	38.33
Feed intake per lamb/day			
1)Roughage (kg)			
i)Green maize (kg)	-	0.321	0.767
ii)Jowar kadbi (kg)	-	0.261	0.575
2)Conc. Mixture(kg)	0.150	0.150	0.150
Cost of roughage (Rs.)			
i)Green maize* (Rs.)	-	0.160	0.383
ii)Jowar kadbi* (Rs.)	-	1.044	2.30
Cost of conc. ** Mixture(Rs.)	1.43	1.43	1.43
Total feed cost per lamb/day (Rs.)	1.43	2.63	4.11
Cost/kg gain /lamb /day(Rs.)	0.70	1.00	1.19

* Green maize, Rs.50/- per qtl. * Jowar kadbi, Rs.400/- per qtl., **Conc. Mixture, Rs.958/- per qtl.

CONCLUSIONS

The more intake of dry matter in stallfed lambs than the grazing and semistallfed group resulted in

the superior growth performance with respect to gain in body weight and body measurements in stallfed group over the other systems. Present study suggested that the sustainable lamb production could be promoted in the agro climatic conditions of Konkan region by supplementation of concentrate mixture and nutritive feeds to the lambs under the stallfed management system.

REFERENCES

Dastagiri M, Rao NA (1990). Economics of sheep farming. Livestock Advisor 26(1): 11-17

Dass G (2007). Production performance and management practices of Pugal sheep in the home tract. Indian Journal of Animal Sciences 77(8): 763-766

Gomez GK, Gomez AA (1983). Statistical Procedures for Agricultural Research. Second Edn. Wiley Inter Science Publ, pp 357-389

Jagtap DZ, Naikare BD (1989). Growth rate in Deccani and its half breds with Merino and Dorset. Indian Journal of Animal Sciences 14(12): 3-7

Johri CB, Talapatra SK (1971). Growth studies with Jamunapari goats, II. Jamunapari kids under browsing and stall feeding conditions. Ind Journal of Veterinary Sciences and Animal Husbandry 48(5): 495-503

Krishnamohan DVG, Naidu CM (1984). Individual vs group feeding of weaned crossbred lambs on two complete rations. Indian Journal of Animal Sciences 54(9): 849-854

Mali SL, Kale KM, Thorat BP (1985). A note on relationship between body measurements in Deccani sheep. Indian Journal of Veterinary Sciences and Animal Husbandry 62(4): 347-348

Saini AL, Prakash B, Khan BU (1986). System of management of relation to growth performance in Jamunapari kids. Indian Journal of Animal Production and Management 2(1):26-29

Singh KS, Arora DN, Balaine DS (1986). Economics of rearing lambs of Nali and its crosses with Chokla and Merino. Livestock Advisor 12: 21-24

Solanki GS (1992). Stall feeding vs range feeding of goats. Indian Journal of Animal Sciences 62(11): 1092-1095

SPSS Inc. (2004). SPSS for windows. Released 13.0 SPSS Inc., Chicago, Illinois, USA

Thorat AN, Koratkar DP, Narawade VS (1990). Greasy wool production and its relation with body weight in Deccani and crossbred sheep. Indian Journal of Animal Sciences 60 (10): 1215-1218

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Comparative Performance of Some Improved Poultry Crossbreds Under Konkan Region of India

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ABSTRACT

The experiment was conducted at Poultry Farm, College of Agriculture, Dr. B. S. Konkan Krishi Vidhyapeeth to assess the comparative performance of some improved poultry crossbred during laying period. The trial was carried out on five different types of improved poultry crossbred namely, - Giriraja x Delham Red (T1), Delham Red x White Leghorn (T2), Giriraja x Asselkala (T3), Delham Red x Giriraja (T4), Asselkala x Giriraja (T5) and two purebred groups like Delham Red and Vanraja. About 147 experimental birds were replicated three times and each replication consisted of seven birds in seven treatments in a Completely Randomized design. The feed consumption during early laying period and peak laying period differed significantly ($P<0.05$) between the groups. The average egg production was significantly ($P<0.05$) different in the treatments during early and peak laying period. The gross returns from the eggs of purebreds was significantly higher ($P<0.05$) than the crossbreds. It can therefore be concluded that, feed consumption is lower in purebreds than crossbreds. The average egg production is more in purebreds as compared to crossbreds up to peak laying period. Considering the minimum feed consumption and feed cost with maximum egg production and gross returns were observed in purebreds vis-a-vis crossbreds.

Keywords: Feed efficiency, Growth parameter, Feeding cost

INTRODUCTION

Poultry farming in India is and internal part of the agricultural industry. The Indian poultry Industry has come a long way from a backyard enterprise to an organized commercial industry. India produces 3-6% of the total global egg production i.e. 61 million tonnes (FAO 2011). The growth rate of egg production is 5-8%. On the other hand the per capita availability of meat is 1.6 kg and per capita availability of egg is about 1.8 kg (42 eggs). Maharashtra is one of the progressive states in India in poultry farming with rapid growth potential. Among the various aspects in poultry science, improvement in genetic makeup by various breeding methods, such as cross breeding to improve the FCR (Feed Conversion Ratio), egg production and egg quality is an important aspect. Poultry farming can be taken up as an integral component in agriculture, particularly under backyard farming and also as supporting enterprises to crop farming. The poultry products like eggs, meat, and yolk powder have more prices and it is consumed in urban and semi-urban areas. It has also been noticed that demand exists for poultry products in rural areas.

Feed conversion efficiency is higher in poultry crossbred as compared to purebred and mortality is also less in crossbred as compared to purebred. These two factors play very important role in increasing profits in poultry production (Dwivedi et al. 1986).

It is therefore necessary to identify potential poultry crossbreds suitable for backyard farming as well as commercial farming in Konkan region of India which are easily adaptable to high rainfall and high humidity environment. With these views, the present study has been conducted on crossbred and purebred poultry birds with primary objective to study the laying performance of improved crossbred and purebreds, feed conversion ratio, egg production, cost of production and egg quality parameters.

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MATERIALS AND METHODS

The study was carried out at the poultry farm of Department of Animal husbandry and Dairy Science, at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra (17°N and 73°E). The area is characterized by hilly terrain. The soil is lateritic and acidic in nature with low fertility and poor water holding capacity. The climate is warm and humid. The area receives heavy rainfall (3611 mm) with 60-90 percent humidity coupled with temperatures ranging from 18.70° to 30.70°C around the year.

The trial was conducted on 147 birds of five different type crossbred poultry birds and two purebred poultry birds. Birds were divided into seven treatments with three replicates consisting of seven birds in each replication. The twenty one birds were allocated in the treatments namely, T_1 - Giriraja x Delham Red, T_2 - Delham Red x White Leghorn, T_3 - Giriraja x Asselkala, T_4 - Delham Red x Giriraja, T_5 - Asselkala x Giriraja, T_6 - Delham Red pure and T_7 - Vanraja pure. The day old chicks were housed in seven different compartments containing clean waterers and feeders in deep litter system up to completion of 8th weeks, and then chicks were transferred to cages up to the laying stage. The birds were fed recommended quantity of feed two times in a day, with clean and fresh drinking water *ad libitum*. The general veterinary aids were provided to all birds with regular vaccinations as per the vaccination schedule for layers. The management practices like deworming debeaking were followed at regular intervals.

The chicks were fed twice a day with commercial egg mash. Clean water was supplied *ad libitum*. Medications and vaccinations were done as and when needed.

Table 1: Chemical composition of experimental feed

Parameter	Egg Mash (%)
Dry Matter	90
Crude Protein	18
Crude Fat	02
Crude Fibre	07
Total Ash	3.5
Calcium	1.4
Phosphorus	0.7
Energy (Kcal)	2644

The experiment was conducted from initial laying stage up to peak egg laying stages of productive cycles of layer namely, early laying stage (21-33 weeks) and peak laying stage (34-40 weeks), the average laying stage being 21-52 weeks.

The feed consumption was determined by subtracting the balance quantity of feed from quantity offered on the previous day. Incidents of sick and dead birds during study were monitored. Weight of the first laid egg was recorded in all groups by digital weighing.

The amount of feed consumed *viz.,* per dozen of eggs and per kg of eggs was also recorded. Egg production was calculated on a Hen day basis by dividing total eggs laid in the period by the average number of birds in the house.

All eggs produced on a certain day of the week were collected separately for different treatment groups and weighed individually with an electronic scale. The width of eggs was measured by vernier calliper. The total eggs were examined for shape index (the ratio of width to length of egg). The egg shell thickness was measured using micrometer (+ µm.). The yolk was separated from the albumen using spoon and weighed with electronic balance. The albumen weight was calculated by subtracting the weight of yolk and shell from the whole egg weight. The albumen index (the ratio of average albumen height to the average of the width and length), yolk index (the ratio of yolk height to its average width) and Haugh unit calculated by using Haugh formula of the ratio of albumen height and egg weight (Nesheim et al. 1979).

Haugh unit = $100 \log [H + 7.57 - 1.7 W^{0.37}]$

Where H = height of albumen (mm) and W = weight of egg (g)

The cost of feeding was worked out considering the prevalent cost of feeds. The experimental data was analyzed statistically with randomized block design (Snedecor and Conhran 1990).

RESULTS AND DISCUSSION

The mean values of the laying performance of improved poultry crossbred and purebred are presented in the Table 2. There were significant difference ($P<0.05$) in the feed consumption values of crossbred and purebreds during early and peak laying period. The result showed that feed consumption in early and peak laying period was

Table 2: Performance of improved poultry crossbred and purebred during experimental period

Parameters	Crossbreds						Purebreds			Mean SE+
	Giriraja x Delham Red	Delham Red x White Leghorn	Giriraja x Asselkala	Delham Red x Giriraja	Asselkala x Giriraja	Mean	Delham Red pure	Vanraja pure	Mean	
Feed consumption(g/bird/day)										
Early laying period (19-33 wk) (g/bird/week)	852.70^{d}	837.70^{d}	847.80^{d}	819.80^{bcd}	790.90^{ab}	829.78	778.00^{a}	796.00^{abc}	787	+6.41*
Peak laying period (34-40 wk) (g/bird/week)	864.70^{f}	867.70^{g}	859.90^{e}	846.90^{d}	839.20^{b}	855.68	836.80^{a}	844.80^{c}	840.8	+4.03*
Age at first lay(days)	124	113	124	136	115	122.4	115	115	115	
Weight of first lay(g)	33.78^{a}	42.75^{e}	36.59^{c}	43.37^{f}	36.30^{b}	38.558	47.16^{g}	36.73^{d}	41.945	+0.14*
Hen day production (%)										
Early laying period (19-33 wk)	40.68^{b}	61.06^{g}	38.95^{a}	47.81^{e}	44.94^{c}	46.688	55.62^{f}	46.68^{d}	51.15	+3.14*
Peak laying period (34-40 wk)	52.71^{d}	51.23^{a}	52.17^{c}	54.87^{f}	53.25^{e}	52.846	58.78^{g}	52.15^{b}	55.465	+1.73*
Average feed conversion efficiency /dozen of eggs										
Early laying period (19-33 wk)	1.59^{bcde}	1.40^{ab}	1.57^{e}	1.52^{abcde}	1.42^{abc}	1.5	1.35^{a}	1.43^{abcd}	1.39	+0.06*
Peak laying period (34-40 wk)	1.45^{g}	1.32^{a}	1.44^{f}	1.33^{b}	1.35^{c}	1.378	1.40^{d}	1.42^{e}	1.41	+0.06*
Average feed conversion efficiency /kg of eggs										
Early laying period (19-33 wk)	5.49^{f}	5.98^{g}	5.28^{b}	5.29^{c}	5.26^{a}	5.46	5.4^{e}	5.34^{d}	5.37	+0.27*
Peak laying period (34-40 wk)	6.08^{c}	6.76^{f}	6.08^{c}	6.40^{e}	6.15^{d}	6.294	6.02^{b}	6.00^{a}	6.01	+0.30*
Mortality pattern (%)	4.76^{a}	9.52^{b}	4.76^{a}	4.76^{a}	4.76^{a}	5.712	4.76^{a}	4.76^{a}	4.76	+0.03*

Means with different superscripts in a row differ significantly (*P< 0.05)

highest at 829.78 and 855.68 g/day/bird in crossbreds than in the purebreds i.e. 787.00 and 840.80 g/day/bird. The results of the investigation are in agreement with Dalivedi et al. (1986) and Dutta et al. (1991). It is observed that purebred groups attained sexual maturity earlier than the crossbred groups. Rao (1977) observed that the age at first egg on improved desi pullets were between 171-190 days of age. The average weight of first lay (g) was higher (P<0.05) in purebreds than the improved crossbreds birds. The hen day production were significantly more (P<0.05) in purebreds than the crossbreds during both early and peak laying periods. Balachandran (1979) also reported that the hen day production of White Leghorn birds ranged from 45.34 to 74.86 (%).

The feed conversion ratio calculated on the basis of dozen egg produced was significantly different (P<0.05) between crossbred and purebreds. During early laying period purebreds utilized their feed more efficiently than the crossbreds. But during peak laying period crossbreds utilized their feed more significantly. Rao (1977) observed feed efficiency/dozen of eggs was highest in indigenous breeds (2.97 kg) as compared to White Leghorn (2.8 kg) and Rhode Island Red (2.9 kg). The feed conversion efficiency ratio based on per kg egg produced was significantly higher in crossbred (P<0.05) during early and peak laying period than the purebred. The maximum mortality was observed in crossbreds as compared to purebreds.

Mean values of various egg quality parameters viz. egg weight, egg shape index, egg shell thickness, yolk weight, albumin weight, yolk index and Haugh unit are shown in Table 3. The egg weight, egg shell thickness and egg shape index in purebreds was significantly higher (P<0.05) than that of crossbreds. The results of investigation are also similar to the findings of Chand et al. (1972), Jahari and Singh (1968) and Mahanta and Sapcota (2007).

The eggs produced by crossbreds had lighter yolk (P<0.05) than those of purebreds. Suk and Park (2001) also found that the yolk weight increased with increase in age of the birds. The albumen of crossbred eggs was lighter than the eggs of purebreds; similarly, Izat et al. (1985) also found that Haugh unit values decreased with increase in age of birds. Many factors have been reported to affect Haugh units such as storage time, temperature, age of birds, strain, nutrition and disease (Toussant and Latshaw 1999).

Table 3: Egg quality parameters in different improved poultry crossbreds and purebreds

Parameters	Crossbreds						Purebreds			Mean SE+
	Giriraja x Delham Red	Delham Red x White Leghorn	Giriraja x Asselkala	Delham Red x Giriraja	Asselkala x Giriraja	Mean	Delham Red pure	Vanraja pure	Mean	
External Egg quality parameters										
Egg weight (g)	46.60^{f}	51.47^{a}	45.79^{g}	48.40^{c}	48.34^{d}	48.12	49.99^{b}	47.63^{e}	48.81	+0.13*
Egg shape index (%)	73.60^{e}	71.78^{f}	73.60^{e}	74.60^{d}	77.19^{a}	74.154	74.35^{c}	75.57^{b}	74.96	+1.87*
Egg shell thickness(mm)	0.45^{c}	0.45^{c}	0.47^{a}	0.46^{b}	0.45^{c}	0.456	0.47^{a}	0.47^{a}	0.47	+0.01*
Internal Egg quality parameters										
Yolk weight(g)	14.54^{g}	14.81^{f}	15.24^{c}	15.06^{e}	15.76^{a}	15.082	15.45^{b}	15.12^{d}	15.285	+1.55*
Albumen weight(g)	27.06^{f}	31.47^{a}	25.78^{g}	28.20^{c}	27.62^{e}	28.026	29.10^{b}	27.77^{d}	28.435	+1.16*
Albumen index (%)	7.53^{e}	7.01^{g}	8.22^{b}	9.06^{a}	8.09^{c}	7.982	7.70^{d}	7.26^{f}	7.48	+1.46*
Yolk index (%)	37.55^{f}	39.89^{a}	36.74^{g}	38.39^{d}	38.16^{e}	38.146	38.61^{c}	39.07^{b}	38.84	+1.16*
Haugh unit	68.45^{f}	66.51^{g}	72.98^{b}	77.50^{a}	69.86^{d}	71.06	71.27^{c}	69.73^{e}	70.5	+6.75*

Means with different superscripts in a row differ significantly (*P< 0.05)

Cost of feed incurred on crossbred and purebred birds are presented in the Table 4. Data revealed that the average minimum feed consumption (17.76 kg), minimum total feed cost (₹230.88) with maximum eggs produced (83.85) and more gross returns (₹ 335.40) was observed in purebreds (T_6). The average minimum feed consumption within crossbreds (17.93 kg) is seen in T_5. The maximum production in terms of number of eggs (82.95) and higher gross returns from eggs (₹ 331.80) was seen in the T_2 group.

CONCLUSIONS

The study concluded that feed consumption was lower in purebreds and they produced more eggs and utilized their feed more efficiently along with more gross returns as compared to crossbreds. The results also proved that the Delhemred purebred was superior to other crossbreds and purebreds. Therefore, rearing of purebreds is a good profitable venture, considering minimum feed consumption and feed cost with maximum egg production.

Table 4: Cost of production of eggs in different improved poultry crossbreds and purebreds

Parameters	Crossbreds					Purebreds	
	Giriraja x Delham Red	Delham Red x White Leghorn	Giriraja x Asselkala	Delham Red x Giriraja	Asselkala x Giriraja	Delham Red pure	Vanraja pure
Average feed consumption per bird (kg)	18.89	18.75	18.78	18.33	17.93	17.76	18.04
Feed cost / kg (Rs.)	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Total cost of feed (Rs.)	245.57	243.75	244.14	238.29	233.09	230.88	234.52
No. of eggs produced per bird up to 40th wk	66.09	82.95	64.23	73.61	71.33	83.85	74.00
Price of egg (Rs.)	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Gross returns from eggs (Rs.)	264.36	331.80	256.92	294.44	285.32	335.40	296.00
Cost of production per egg (Rs.)	3.71	2.93	3.80	3.23	3.26	2.75	3.16
Net returns (Rs.)	18.79	88.05	12.78	56.15	52.23	104.52	61.4
Benefit Cost Ratio	1.07	1.36	1.05	1.23	1.22	1.45	1.2

REFERENCES

Balachandran TN, Unni AKK, Venugopalan CK (1979). A note on production characteristics of White Leghorn pullets in cages and on litter floor. Indian Poult Gaz 63(2): 83-85

Chand D, Arora KL, Arneja DV (1972). Egg size and yolk cholesterol content in White Leghorn and four indigenous breeds of Indian fowl. Indian J Poult Sci **7**(1): 13-15

Dutta KK, Sharma PK, Bora NN (1991). Studies on feed consumption and feed conversion to egg-mass of Miri birds of Assam White Leghorn and their crossbreds under different system of management. Poult Today and Tomorrow 1(3):11-19

Dwivedi HB, Singh C, Kushwaha NS (1986). Study on mortality and feed conversion efficiency in inbreds and their crosses. Poultry Guide, pp 44-47

Izat AL, Gardner FA, Mellor DB (1985). The effects of age of birds and season of the year on egg quality, Haugh units and compositional attributes. Poult Sci 65: 726-728

Johari DC, Singh BP (1968). Studies on internal egg quality influence of breed, season and age of the birds. Indian Vet J 45(2): 39-143

Mahanta JD, Sapcota (2007). Effect of dietary growth promoter on the productive performance of commercial layers. Indian J Anim Sci 77(10): 1039-1040

Nesheim MC, Austic RE, Card LE (1979). Poultry production 12th Ed. Philadelphia (USA): Lea and Febiger, p 339

Rao GV (1977). Studies on selective breeding, upgrading and cross breeding for improvement of egg production in Desi fowls. Indian Poult Gaz 61(2): 45-54

Snedecor GW, Cochran WG (1994). Statistical Methods, 8th Ed. Iowa state University Press, Ames, Iowa

Suk Y, Park C (2001). Effects of broiler breeder age and length of egg storage on albumen characteristics and hatchability. Poult Sci 80: 855-858

Toussant MJ, Latshaw JD (1999). Ovomucin contents and composition in chicken eggs with different interior quality. J Sci Food and Agri 79:1666-1670

Indian Journal of Hill Farming 25(1):53-57 Available online at www.kiran.nic.in

Agriculture Practices and Its Association with Livestock in Hilly Areas of West Bengal

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ABSTRACT

The present study was done to evaluate the socio-economic condition as well as existing farming system practised in hilly areas of West Bengal. Data were obtained by formal interview using a pretested structured questionnaire. Level of crop diversification, animal rearing pattern and income from individual sector were compared among different land holdings. Most of the farmers practice medium level (<0.5 to >0.7) of crop diversification. The percent wise allocation of gross cropped area was maximum for cereals (57.79%), followed by vegetable (22.15%) and plantation (6.67%). This trend is similar for all categories of farmers. Non-descript cows constituted the major population of dairy animals followed by cross-breeds, while few farmers are getting their maximum return from piggery. The diversification of animals rearing varied as various communities living at different altitudes. Overall, livestock constitutes 19.65 % of total income, but in case of large farmers it was 25.06%.

Keyword: Crop diversification, Hill agriculture, Integrated Farming system, Livestock

INTRODUCTION

Globalization of market and change in agriculture trade and tariff policies called for drastic innovative changes of existing farming systems. In this era of stagnation and falling profitability of crop farming (Kumar et al. 2006), diversification of crop based agriculture with introduction of dairy, goatery, fishery, poultry, duckery, etc. has become imperative. The hilly areas of West Bengal constrained with the more availability of good and large extent of agricultural land. Agriculture along with animal rearing is the usual practice of total farming system. Lack of irrigation facility and lack of facilities for modern integrated farming are the major factor for low productivity. Yet the majority of the families depend solely on agriculture and allied activities to meet their livelihood. Thus a study is taken to evaluate the predominant farming systems in hilly areas of West Bengal.

MATERIALS AND METHODS

The hilly areas of West Bengal covering some parts of Darjeeling district is taken as study area. It is a position of the hill zone of West Bengal with an average elevation of 1249 m above mean sea level with steep slopes. The soils are soft and loose in character

Information gathered from the farmers at different villages to evaluate their socioeconomic status particularly, how the resources are well managed to meet their livelihood. Data were collected through formal interview using a pretested structured questionnaire from farmer by multi-stage stratified random sampling method. In the first stage, four blocks (Kalimpong-I, Kalimpong-II, Ronglirongliot and Garubathan) were selected randomly from the hilly areas of West Bengal. Three villages were randomly selected from each of the selected blocks. Finally six farmers were randomly selected from each of the villages. The farmers are divided into four categories according to their land holding viz. marginal (< 0.5 ha), small (>0.5 ha to <= 1 ha), medium (> 1 ha and <= 1.5 ha) and large (> 1.5 ha). The data were collected during the agricultural year 2011. Crop diversification index was calculated by using Simpson Index of diversity referred by Joshi et al. (2003).

Simpson index of diversity: $I_i = 1 - (\Sigma Si^2) - (\Sigma Si)^2$

Where Si is the share of crop 'i' in gross cropped area. A high Simpson index indicates greater crop

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diversity, while a low index reflects more specialization. Diversification index greater than 0.7 was considered as high, and less than 0.5 as low for different categories of farmers. Data collected in this survey were analysed by using SPSS-16 Software and LSD were tested by one-way ANOVA.

RESULTS AND DISCUSSION

Farmers' category

The majority of farmers in hilly areas belong to the small category (40.27%), followed by marginal (31.94%). Very few farmers belong to medium (11.11%) and large (16.66%) category (Table 1).

Table 1: Category of farmer in Kalimpong sub division according their land holding

	No of farmer	Percentage (%)
Total no of farmer= 72		
Marginal Farmers(<=0.5)	23	31.94
Small farmers(>0.5 H<=1H)	29	40.27
Medium Framers (> 1 and <=1.5H)	8	11.11
Large farmer(> 1.5 H)	12	16.66
Total	72	

* H- Hectare

Land Allocation pattern

The overall mean holding of this area varies between 0.34 ha (for marginal) to 2.00 ha (for large farmer). The holding size in this area is found to be smaller as compared to Western Uttar Pradesh (Singh and Gangwar 2010) due to land reform policies adopted by Government of West Bengal (Banerjee et al. 2002). The percent wise allocation of gross cropped area was maximum for cereals (57.79%), followed by vegetable (22.15%) and plantation (6.67%). The trend is similar for all categories of farmers. The share of land towards cereals increased slightly with the increase in land holding, whereas small and marginal farmers allocate more land for the cultivation of vegetables compared to medium and large farmers. The cropping intensity was lowest (137.5%) for large farmers due to less availability of own human labour (Table 2). While working at Uttar Pradesh Singh and Gangwar (2010) have observed almost similar trend. The soil and climatic conditions in the hilly areas are not favourable for oilseed and pulse cultivation.

Level of Crop Diversification

Analysis of the field data revealed that irrespective of categories, farmers showed their maximum tendency towards medium level (>0.5 to <0.7) of diversification, *viz.* 60.86%, 65.51%, 87.5% and 66.66% respectively for marginal, small, medium and large category. Crop diversification is more prevalent features among the marginal and small farmers. At higher (>0.7) crop diversification small and marginal farmers recorded higher value (13.79% and 8.69% respectively) as compared to medium and large farmers (0% for both). The obtained value indicates that the increase in holding size decrease the diversification index (Table 3). This is may be due to the fact that marginal and small farmer poses small piece of land but plenty

Table 2. Cropping pattern of sample households in hilly zone of West Bengal
(in % of gross cropped area allocated to different crop enterprise replicated for each farmer)

	Total	Marginal (<=0.5 ha)	Small (>0.5 ha & <=1 ha)	Medium (>1 ha & <=1.5 ha)	Large (>1.5 ha)
N	72	23	29	8	12
Cereals	57.79	43.44	56.81	60.95	62.50
Pulses	2.95	5.38	2.42	0.0	4.24
Oilseeds	3.25	3.26	4.47	6.63	0.0
Vegetables	22.15	31.88	24.81	15.40	19.26
Plantations	6.67	9.78	2.73	10.39	7.88
Horticulture	6.50	6.28	6.86	6.63	6.12
Spices	0.70	0.00	1.89	0.0	4.24
Gross cropped area (ha)	1.39	0.53	1.27	2.26	2.75
Net cropped area (ha)	0.87	0.30	0.74	1.23	2.0
Cropping intensity	159.77	176.67	171.62	183.74	137.50

ha- hectare

of human labour, the scenario is just reversed for medium and large farmers.

Farming system wise analysis indicated that most of the vegetable based farmers (66.66%) come under high level of diversification, followed by horticulture (55.55%), piggery (50%), dairy (30%) and plantation based (25%) farmers. Majority of farmers in cereal based system comes under medium levels of diversification (66.66%). Small and marginal farmers with their available family labour allocate their land more towards the vegetable cultivation as well as horticulture, which are labour intensive and profitable. Thus highest level of diversification observed in vegetable and horticulture based system.

Farm income

Net income from crop production and livestock production was calculated after deducing total cost from the gross income. The income from individual farmer is positively related with the size of holding. The income per farm family increases from marginal (Rs. 66309) to medium farmer (Rs. 234276) but this income for large farmer (Rs. 166333) was less than that of medium farmer. Among the different agricultural component vegetable (Rs. 78067) recorded the highest income, followed by horticulture (Rs. 13945), dairy (Rs. 13577), piggery (Rs. 10582) and cereals (Rs. 4759) (Table 4). Though cereals occupied the largest area (57.79%) for agriculture land, they contributed only

Table 3: Number of farmers under each category with different levels of crop diversification

Basis of categorization	Category of farmer	No of house hold in different level of diversification			
		Low(<=0.5)	Medium (>0.5and<=0.7)	High(>0.7)	Total
According to Land Holding	Marginal	7(30.4%)	14(60.86%)	2(8.69%)	23
	Small	6(20.68%)	19(65.51%)	4(13.79%)	29
	Medium	1(12.5%)	7(87.5%)	0(0.0%)	8
	Large	4(33.33%)	8(66.66%)	0(0.00%)	12
According to Farming System	Cereals	1(33.33%)	2(66.66%)	0(0.0%)	3
	Vegetable	1(3.03%)	10(30.30%)	22(66.66%)	33
	Horticulture	1(11.11%)	3(33.33%)	5(55.55%)	9
	Plantation	1(12.50%)	5(62.50%)	2((25.0%)	8
	Dairy	3(30.0%)	4(40.0%)	3(30.0%)	10
	Goatery	0(0.0%)	1(100.0%)	0(0.0%)	1
	Piggery	0(0.0%)	3(50.0%)	3(50.0%)	6

Table 4: Income from various agricultural sectors per farm per annum over different farm size in hilly zone of West Bengal

(data in parenthesis indicating the % share of that particular component out of total income)

Components	Total	Marginal	Small	Medium	Large	
Cereals	4759 (3.57)	1144^{b}(1.73)	4040^{b} (2.79)	7067^{b} (3.02)	11889^{a} (7.15)	*
Oilseed	68 (0.05)	22^{ab}(0.03)	81^{ab} (0.06)	249^{a} (0.11)	0^{b} (0.00)	*
Vegetable	78067 (58.89)	39925(60.21)	96244 (66.49)	142419 (60.79)	64341^{a} (38.68)	NS
Horticulture	13945 (10.47)	4338^{b}(6.54)	15070 ^{ab} (10.41)	17894^{ab} (7.64)	27008^{a} (16.24)	*
Pulses	1736 (1.30)	171(0.26)	3076 (2.13)	0 (0.00)	2652 (1.59)	NS
Plantation	846 (6.35)	4522^{b}(6.82)	2892 ^{b}(2.00)	24562^{a} (10.48)	18757^{a} (11.28)	*
Total crop share	99421 (80.63)	50123(75.59)	121403 (83.88)	192191 (82.04)	124648 (74.94)	
Dairy	13577 (10.19)	893^{b} (13.47)	13291^{b} (9.18)	34118^{b} (14.56)	9482^{a} (5.70)	*
Goatery	926 (0.69)	859 (1.29)	1211 (0.84)	893 (0.38)	387 (0.23)	NS
Piggery	10582 (7.94)	5800 (8.75)	7520 (5.20)	6833 (2.92)	29643 (17.82)	NS
Poultry	918 (0.69)	597(0.90)	903 (0.62)	239 (0.10)	2021 (1.22)	NS
Apiary	191 (0.14)	0 (0.00)	411 (0.28)	0 (0.00)	153 (0.09)	NS
Total livestock share	26194 (19.65)	16186 (24.41)	23336 (16.12)	42085 (17.96)	41685 (25.06)	
Total	125615 (100)	66309 (100)	144739 (100)	234276 (100)	166333 (100)	

NS- non significant

Similar alphabets (a, b, etc) along rows denotes homogeneous (P>0.05) shares (Duncan's test)

Similar alphabets (a, b, etc) along column denotes homogenous (P>0.05) shares (Least Significant Difference test)

3.57% of total return of the farming system. Whereas, farmers allocated only 22.15% land area and got 58.89% of total return from vegetable cultivation (Table 2 and Table 4). This is due to fact that the farmers in this area cultivate the cereals in a neglected way and got very poor yield, whereas, the vegetable cultivation (especially off season) is very remunerative and farmers put their maximum resource and attention.

The livestock rearing pattern shows that, number of livestock increases slightly with increase in size of holding (Fig.1). This is due to the fact that livestock ensures better utilization of agricultural by-products as well as reduces the uncertainty of agriculture. Non-descriptive (*desi*) cows constitute the major population of dairy animals followed by cross-breed and jersey (Table 5.). This indicates that the farmers were less interested in keeping the crossbred cows because the price of milk is not attractive and non-descriptive (*desi*) cows require less care and management as well as having more disease resistant capacity compared to cross-breed and jersey. Similar types of observations were recorded by Singh et al. (2009). In this area farmers are disinterested in sheep-rearing due to lack of demand of mutton compare to chevon. The number of milch cow (cross-breed and local) reared per farmer was significantly greater among large (1.6) and medium (1.62) compare to small (0.51) and marginal (0.43) farmers (Table 5).

Cropping system contributed 80.63% of total farm income. This share was 75.59%, 83.88%, 82.04% and 74.94% for marginal, small, medium and large farmers respectively. Whereas, livestock contributed 19.65% of total return and this share was 24.41%, 16.12%, 17.96% and 25.06% for

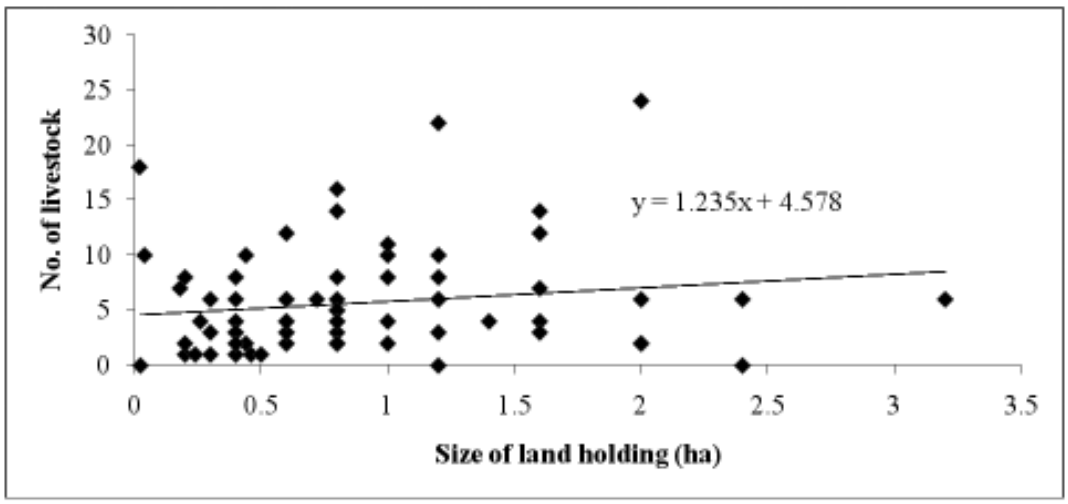

Fig. 1: Effect of holding size on number of livestock in Hilly areas of West Bengal

Table 5: Farm size wise livestock pattern of households in different study zones

(No. of animals/farmer in each category)

Category of Livestock	Total (n=72)	Marginal (n=23)	Small (n=29)	Medium (n=8)	Large (n=12)	Sig.
Milch cow (Cross bred)	0.8	0.43[b]	0.51[b]	1.62[a]	1.6[a]	*
Milch cow (local)	1.95	0.86[c]	1.34[c]	4.62[a]	3.75[b]	*
Milch cow (Jersy)	0.16	0.0	0.0	0.5	0.66	NS
Bullock	0.75	0.56	0.51	0.75	1.66	NS
Calves	0.72	0.52	0.72	0.87	1.0	NS
Goat	1.55	1.86	1.44	1.75	1.08	NS
Sheep	0.0	0.0	0.0	0.0	0.0	NS
Pig	2.59	2.08[b]	3.0[ab]	3.25[a]	2.16[b]	*
Poultry	2.84	3.13[a]	2.86[a]	0.75[b]	3.6[a]	*

Similar alphabets (a, b, etc) along rows denotes homogeneous (P>0.05) shares (Duncan's test)
Similar alphabets (a, b, etc) along column denotes homogenous (P>0.05) shares (Least Significant Difference test)

marginal, small, medium and large farmers respectively. These findings are supported by Khatun and Roy (2012).

The number of pig and poultry per farmer was more compared to all other livestock animal in the hilly areas. The number of pig per farmer was maximum in medium category farmer and it was significantly varied from others. In case of poultry rearing the number of bird per farmer was higher in large category farmer which was at-par with marginal and small but significantly varied from medium category farmer.

CONCLUSIONS

This study reveals that in hilly areas of West Bengal as the size of holding increases, crop diversification decreases with the increase in number of livestock and more allocation of lands towards vegetables. Among the different livestock piggery is popular in this area. Livestock contributed only 19.65% of total income. This indicates that livestock is a subsidiary enterprise with tremendous potential for further growth.

REFERENCES

Banerjee A, Gertler P, Ghatak M (2002). Empowerment and Efficiency: Tenancy Reforms in West Bengal. Journal of Political Economy 110 (2): 239-280

Joshi PK, Gulati AA, Birthal PS, Tewari L (2003). Agriculture diversification in South Asia: Pattern, determinants and policy implications. Discussion Paper No. 57. Market structure studies division. International Food Policy Research Institute Washington DC

Kumar P, Singh NP, Murthy VC (2006). Sustainable agriculture and rural livelihoods: A synthesis. Agricultural Economics Studies 32 (6): 850-75

Khatun, Roy BC (2012). Rural Livelihood Diversification in West Bengal: Determinants and Constraints. Agricultural Economics Research Review 25 (1): 115-124

Singh SP, Gill MS, Gangwar B, Singh MP (2009). Livestock in irrigated system of Uttar Pradesh. Indian Journal of Animal Sciences 79 (9): 925-931

Singh SP, Gangwar B (2010). Economics of crop livestock production in Uttar Pradesh. Indian Journal of Animal Sciences 80 (9): 924-931

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Women Dairy Farmers and Decision Making Pattern in Sonitpur District of Assam

J. Sarma, S. Payeng

INTRODUCTION

The women folk are considered the backbone of the nation and better half of the men in almost all spheres of community development. Rural women constitute about 50% of total rural population. They play a vital role in all spheres of economic life and contribute richly towards national income. Of the major rural enterprises, dairy enterprise has been regarded as an important instrument of economic and social change and supplement to the income and employment to rural women.

Livestock rearing is an important means of income generation in villages for all categories of farmers including small, marginal and even landless farmers in rural India. Milk production and processing of milk for product preparations play a vital role in India's agricultural economy. Dairying is an important means of livelihood to millions of rural poor farmers. The per capita availability of milk in our country has gone up from 112g in 1950-1951 to 218g today. But despite having 11.48 million cattle and 0.96 million buffalo population in north-eastern region, the per capita availability of milk in this region is only 77g against all India average of 218g.

In addition, the small and marginal farmers get cash by selling milk and milk products to purchase seeds, fertilizers etc. for crop production. The role of rural women in agriculture and livestock sector is always neglected. The rural women are denied their status as active producers in these sectors. They have less access to technology, credit, training etc. It is important to understand the role and contribution of farm women for future planning of extension services to fit their needs. Krishi Vigyan Kendras are playing a crucial role in catering the needs of farm women in rural India.

In rural India, cattle and buffalo rearing has been traditionally been a responsibility of farm women. The government of India report indicates that 85 percent of rural women are engaged in livestock production (Viswanathan 1989). But in most instances, in spite being the major contributor in cattle and buffalo production, farm women have been left out from extension programmes of animal husbandry. In addition to this, the extension service work is a male dominated area where farm women have some hesitation to inquire regarding reproduction related problems. These might be the reasons for slow progress in this area. Various micro level studies highlight womens' significant role in dairy production (Jain and Verma 1992; Singh et al. 2005).

The study was conducted in Sonitpur district of Assam. The data were collected through a personal interview schedule in randomly selected 140 farm women from 14 villages of 7 developmental blocks of the district.

Contribution of farm women in dairy production activities was studied with respect to their percent involvement in decision making process. Involvement in decision making of an individual family member may not be of the same level for all activities of dairy production. In some cases, the farm women might take decision of their own, while in others they might not be involved at all. The involvement of farm women in decision making was studied under category of feeding, breeding, management, health care and processing of milk. The farm women were asked to indicate who was taking decision in each activity on a four point continuum *viz.* Decision taken by spouse alone (independent decision), spouse + house wife + other family members / friends/ relatives (collective decision), house wife + spouse (joint decision) and house wife alone (independent decision). In the event of the respondent not responding to an activity, no response was recorded. As can be seen the continuum was in ascending order with respect to the perceived level of involvement, the spouse

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being an independent decision maker at one end of the continuum and farm women being the independent decision maker at the other, the involvement of farm women gradually increase from one end of the continuum to the other.

RESULTS AND DISCUSSION

Feeding

Dairy animal feedings are normally performed by farm women except taking animals for grazing and chaffing the fodder, although farm women are also involved in these activities. The data presented in Table 1 revealed that farm women are involved in the decision making process in most of the activities either independently or jointly with the spouse. It is seen that in matters like whether concentrates are to be fed or not (48.57%), quantity of concentrate to be fed (56.43%), green fodders are to be fed or not (32.86%), quantity of crop residue to be fed (62.86%), fodders are to be chaffed or not (34.26%), most of the farm women were reported to be taking decisions independently. In matters like whether mineral mixtures are to be fed or not (43.57%), frequency of feeding mineral mixtures (40.71%), quantity of green fodders to be fed (30%) and method of straw storage (45%) the decisions were taken by spouse only independently. The above table also indicated that silage/hay making is not practised by majority of farmers in the area under study and a high percentage of respondents (60.71%) did not respond to this activity.

The findings of this study are in consonance with the results of Singh and Srivastava (2012) and Dubey et al. (1982) that farm women are involved in decision making process in feeding the dairy cattle and buffaloes.

Breeding

Table 2 indicates that the farm women are not much involved in the decision making process in breeding activities of dairy animals, whether adoption of AI or natural service or whether or not go for pregnancy diagnosis. Dubey et al. (1982) and Singh and Srivastava (2012) had also reported similar results.

Most of the breeding activities are outdoor activities which require the animal to be taken outside the home to the veterinary hospital, generally located at a distance from the village. This might be the reason of poor participation in decision making in these activities by the farm women. In addition, this is a time consuming process for farm women as they have other domestic and livestock-related works at home to perform. The decisions are therefore taken by the spouse.

Management

Management of dairy animals is very important part of dairy animal production system. Most of

Table 1: Involvement of farmwomen in decision-making in FEEDING (n = 140)

Sl. No.	Activities / Task	Decision-making pattern				
		Spouse only (%)	Collective (%)	Joint (%)	Farmwomen only (%)	% non-respondents
1	Concentrates are to be fed or not	8.57	16.43	26.43	48.57	-
2	Quantity of concentrate to be fed	12.86	10.71	20.00	56.43	-
3	Mineral mixtures are to be fed or not	43.57	7.86	27.86	16.43	4.29
4	Frequency of feeding minerals	40.71	9.29	31.43	14.29	4.29
5	Green fodders are to be fed or not	26.43	12.14	28.57	32.86	-
6	Quantity of green fodders to be fed	30.00	10.71	29.29	27.86	2.14
7	Quantity of crop residue to be fed	12.14	5.00	24.29	62.86	2.86
8	Silage or hay making	5.71	2.86	7.14	23.57	60.71
9	Fodder chaffing	35.71	19.29	9.29	34.26	1.43
10	Straw storage method	45.00	23.57	7.86	20.00	1.43
	Overall average	26.07	10.79	21.22	34.20	7.72

Collective = All family members / relatives / friends
Joint = Spouse and farm women only

Table 2: Involvement of farmwomen in decision-making in BREEDING (n = 140)

Sl. No.	Activities / Task	Decision-making pattern				
		Spouse only (%)	Collective (%)	Joint (%)	Farmwomen only (%)	% non-respondents
1	Adoption of AI or natural service	79.26	12.86	5.71	-	2.14
2	Bull selection in case of natural service	86.43	7.14	6.43	-	-
3	Treatment of animals with reproductive disorders	75.00	15.00	7.14	2.86	-
4	Pregnancy diagnosis	66.43	9.26	12.14	1.43	10.71
	Overall average	76.78	11.07	7.86	1.07	3.21

Collective = All family members / relatives / friends
Joint = Spouse and farm women only

the management activities are indoor activities and most of these need monetary involvement. Table 3 showed that decisions about weaning of calves (59.29%), keeping the animal in open or in shed (60.71%), time of milking (79.26%) and number of times the animals are to be milked (78.57%) were taken by farm women alone, while decisions about whether the shed is to be pucca or kutccha was decided jointly by the farm women and the spouse (44.26%), although in 30% of the cases, the decision is taken by the spouse alone. In regard to the number of dairy animals to be kept by the family was mainly a joint decision of the house wife and the spouse although about 26.43 percent respondents reported it as collective family decision.

It was observed that in this area of management of dairy animals, activities requiring monetary involvement was decided either by jointly by the farm women and the spouse or collectively by the family. Activities like feeding colostrum and shed to be disinfected or not were not responded by a large number of respondents as they were unaware about these important management practices.

Health Care

It was observed from Table 4 that a large number of respondents failed to respond to the activity like vaccination is to be done or not (52.14%) and deworming of dairy animals (61.43%). This is probably because of ignorance of the farm families of the area to these important health care activities. However, 30.71% of the respondents reported that the decision about vaccination was taken by the spouses only. About 15% of the respondents reported that the spouse decided the matter of deworming schedule to be followed. Regarding treatment of sick animals, majority of respondents

Table 3: Involvement of farmwomen in decision-making in MANAGEMENT (n = 140)

Sl. No.	Activities / Task	Decision-making pattern				
		Spouse only (%)	Collective (%)	Joint (%)	Farmwomen only (%)	% non-respondents
1	Weaning of calves	5.71	7.86	6.43	59.29	20.71
2	Animals are to be kept in open or in shed	2.14	22.14	14.29	60.71	0.71
3	Shed to be pucca or kutccha	30.00	10.71	44.26	15.00	-
4	Colostrum to be fed to the new born calf or not	7.14	19.29	2.14	3.57	67.86
5	Number of dairy animals to be kept	20.00	26.43	40.00	13.57	-
6	Shed to be disinfected or not	25.00	19.26	7.86	5.00	42.86
7	Number of times animals are to be milked	2.14	12.86	6.43	78.57	-
8	Time of milking	2.86	12.86	5.00	79.26	-
	Overall average	11.87	16.43	15.80	39.37	16.52

Collective = All family members / relatives / friends
Joint = Spouse and farm women only

Table 4: Involvement of farmwomen in decision-making in HEALTH CARE (n = 140)

Sl. No.	Activities / Task	Decision-making pattern				
		Spouse only (%)	Collective (%)	Joint (%)	Farmwomen only (%)	% non-respondents
1	Vaccination to be done or not	30.71	12.14	5.00	-	52.14
2	Treatment of sick animals to be done or not	39.29	25.71	20.00	4.26	10.71
3	Deworming schedule to be followed or not	15.00	9.26	11.43	2.86	61.43
	Overall average	28.34	15.71	12.14	2.37	41.43

Collective = All family members / relatives / friends
Joint = Spouse and farm women only

reported that the decision was taken either by the spouses themselves (39.29%) or it was taken in consultation with the farm women (20%), or that was a collective decision (25.71%).

Singh and Srivastava (2012) reported similar finding while Dubey et al. (1982) had, however, that the housewife was involved in decisions regarding the health care of dairy cattle and buffaloes.

Processing of milk

The activities in the processing of milk for product making as revealed from Table 5 are indoor activities and are mainly within the home domain of farm women. It is seen from the table that activities like quantity of milk to be used for home consumption (46.43%) and type of milk product to be made from surplus milk (59.29%) was decided by the farm women themselves, although 20.71% respondents also reported that they were taking decisions in consultation with their spouse with regard to quantity of milk to be used for home consumption. About 30% respondents said it was a collective decision for whether the surplus milk to be sold or processed for product making.

Being the homemaker and housewife, the farm women have to look into and cater to the nutritional requirements, needs and tastes of other family members. This might be the probable reason of involvement of the farm women in decision making process with regard to quantity of milk to be used for home consumption and type of milk product to be made. These findings are in agreement with the conclusions arrived at by Dubey et al. (1982), Saraswati et al. (1987) and Singh and Srivastava (2012).

Regarding breeding and health care activities of dairy animals, the decisions were taken by the spouse or livestock owners alone or collectively by the family. The farm women had very low involvement in decision making in these activities of dairy husbandry. There is a need to provide technical knowledge and guidance to the farm women to increase their participation in decision making in these areas of dairy animal production for an overall improvement. It can be concluded

Table 5: Involvement of farmwomen in decision-making in PROCESSING OF MILK (n=140)

Sl. No.	Activities / Task	Decision-making pattern				
		Spouse only (%)	Collective (%)	Joint (%)	Farmwomen only (%)	% non-respondents
1	Quantity of milk to be used for home consumption	2.86	29.29	20.71	46.43	0.71
2	Surplus milk to be sold/ processed for products	12.14	30.00	23.57	27.14	7.14
3	Type of milk product to be made	7.86	26.43	5.71	59.29	0.71
	Overall average	7.62	28.57	16.66	44.29	2.85

Collective = All family members / relatives / friends
Joint = Spouse and farm women only

that most of the decisions related to feeding, management, and processing of surplus milk for product preparations were taken by farm women either independently or jointly with their spouses.

REFERENCES

Dubey VK, Singh SB, Khera JK (1982). Role of rural women in decision-making with respect to animal husbandry practices. Indian Journal of Home Science 14(2):18-21

Jain V, Verma SK (1992). Nature and extent of involvement of men and women in animal husbandry operations. Indian Dairyman 44(7): 332-337

Saraswati LS, Padma AV, Perumal P (1987). Position of farm women in Tamil Nadu: A report on a general study on farm women in villages of Keelapavoor (Tirunelveli) and Palur (South Arcot). A research project sponsored by DANIDA

Singh B, Srivastava S (2012). Decision making profile of Ummednagar village of Jodhpur district. Indian Res J of Extension Education, Special Issue 1: 235-137

Singh P, Mishra BA, Singh B (2005). Assessment of women role in animal husbandry: Proceedings of National Seminar on Entrepreneurship on development for livelihood security-Experiences, Prospects and Strategies for Rural India. IVRI, Izatnagar, India. pp 68

Viswanathan B (1989). Women in livestock in India. A desk study for FAO regional office for Asia and Pacific, Bangkok, Thailand

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A Preliminary Note on Assessment of a Few Indigenous Ornamental Fishes of Northeast India as Potential Predators of Mosquito Larvae

S. K. Das

Keywords: Ornamental fish, Mosquito larvae, Low cost feed

INTRODUCTION

Biological control, particularly using larvivorous fish, is important to malaria control programmes in the 20th century, particularly in urban and periurban areas for immediate use in developed and developing countries (Gratz and Pal 1988).

Mosquitoes are found all over the world and it is considered as pests. Many countries have adopted several measures to control the population of mosquitoes in order to reduce the incidence of malaria and other mosquitoes borne diseases. Mosquitoes are prolific breeders and have adapted to almost all types of climatic conditions.

Fish consumes varieties of food in live, moist, dry or in frozen condition. Among the live food, mosquito larvae is one of the most favourite feeds for the larvivorous fish such as *Gambusia affinis* (Baird & Girard) and Guppy, *Poecilia reticulate* (Peters). Both belong to Order Cyprinodontiformes and family Poecilidae. Many types of mosquito-eating fish have been used in control programs across the world (Walton 2007). Currently, the use of fish is tempered by two concerns. First, introducing non-native fish can have dramatic consequences on the aquatic environment. *Gambusia* is a voracious and highly aggressive fish that compete with the native fish very successfully for viable food and space. *Gambusia* essentially depletes all large zooplankton while rotifers and phytoplankton densities increase (Hurlbert and Mulla 1981; Bence 1988).

Both Gambusia and Guppy being invasive in nature (Rehage et al. 2005; Manna et al. 2008) may compete with the indigenous fish species as well as other aquatic organisms that use mosquito larvae as food. Further, their existence in the natural waters may have adverse effect on the abundance of indigenous aquatic organisms.

In different regions of the world, indigenous fishes have been used for mosquito control (Morton et al. 1988; Neng et al. 1987; Kim et al. 1994). Most of these indigenous larviviorous fishes provide dual benefits by reducing the mosquito populations and indirectly augmenting the aquacultural economics (Menon1991; Sharma and Ghose1994; Walton 2007; Chandra et al.2008). The suitability of indigenous air-breathing fishes as predators of mosquito larvae were assessed by Bhattacharjee et al.(2009).

In view of growing importance on biological control of mosquitoes; a few indigenous fishes were evaluated to assess their predation potential in a laboratory experiment.

Five indigenousornamental fish species of the northeast India, viz. *Mystus bleekeri,Channa stewartii, Rasbora daniconius, Colisa fasciatus*and *Danio aequipinnatus* were selected for the experiment. These species of size ranging between 6-10 cm in total length were collected from the local wet lands and marshy areas and brought to the laboratory. They were separately reared in glass aquaria for 5 days and fed with commercial aquarium fishfood and plankton. Individual fishes were starved for a period of 18 hours prior to the actual experiment. The experiment was conducted during the monsoon period in the month of July in order to obtain adequate numbers of mosquito larvae. Initially a few mosquito larvae were collected from the local stagnant water bodies by a

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net of small mesh size. Later they were introduced in a separate fibre glass tank of 30 litre capacity for culturing mosquito larvae. The tank was filled with fresh water. One medium sized potato was cut into pieces and placed in the tank along with a small quantity of cow dung (about 250 gm). The tank was then placed in a corner of the laboratory undisturbed. The media attracted the mosquitoes to lay eggs and within 5-7 days, large number of mosquitoes was seen in the media. These larvae metamorphose in to pupae that ultimately molts into mosquito. Using a scoop net of small mesh size these larvae were harvested to feed the experimental fishes.

RESULTS AND DISCUSSION

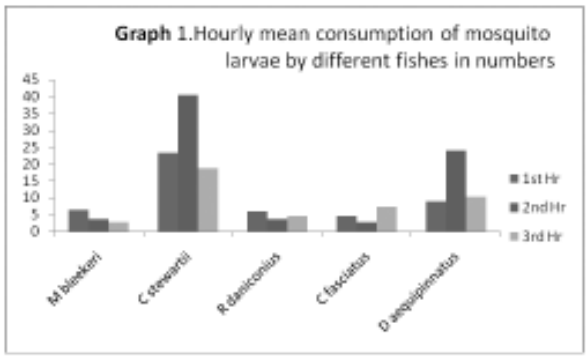
The rate of predations by selected fishes was determined in a glass beaker of 2 litre capacity. A total of 100 nos. of mosquito larvae were first introduced into the beaker prior to the release of individual fish. Each fish was allowed to predate upon the mosquito larvae for three hours at a stretch in the glass beaker with three replicates. The number of mosquito larvae consumed by each fish was recorded at one hour interval (Graph 1).

The preliminary experiment conducted on predation of mosquito larvae by a few indigenous

Table 1: Consumption rate of mosquito larvae by five different indigenous fish species of ornamental value under laboratory condition

Fish Species	Size(Mean +SD) cm.	Time taken(Hr)	Beaker-I	Beaker-II	Beaker-III	Pooled data (Mean consumption + SD)
Mystus bleekeri	8.03+ 0.47	1st Hour	10	04	05	6.33+3.21
		2nd Hour	02	06	03	3.66+2.08
		3rd Hour	02	05	01	2.66+2.08
		Total consumption in 3 hours	14	15	09	12.66+3.21
		Mean consumption /Hr+ SD	04.66+4.62	05+1.0	03+2.0	4.22+1.07
Channa stewartii	8.83+1.04	1st Hour	22	05	43	23.33+19.03
		2nd Hour	76	28	17	40.33+31.37
		3rd Hour	16	25	15	18.66+5.50
		Total consumption in 3 hours	114	58	75	82.33+28.71
		Mean consumption /Hr+ SD	38+33.04	19.33+12.50	25+15.62	27.44+ 9.57
Rasbora daniconius	6.60+ 0.53	1st Hour	04	06	08	6.0+2.0
		2nd Hour	02	04	05	3.66+1.53
		3rd Hour	04	06	04	4.66+1.15
		Total consumption in 3 hours	10	16	17	14.33+3.78
		Mean consumption /Hr+ SD	3.33+1.15	5.33+ 1.15	5.66+2.08	4.77+1.26
Colisa fasciatus	7.53+0.64	1st Hour	04	04	06	4.66+1.15
		2nd Hour	03	02	03	2.66+0.57
		3rd Hour	04	08	10	7.33+3.05
		Total consumption in 3 hours	11	14	19	14.66+4.04
		Mean consumption /Hr+ SD	3.66+0.57	4.66+3.05	6.33+3.51	4.88+1.35
Danio aequipinnatus	7.43+0.60	1st Hour	05	12	10	9.0+ 3.60
		2nd Hour	17	20	35	24.00+9.64
		3rd Hour	10	09	12	10.33+1.53
		Total consumption in 3 hours	32	41	57	43.33 + 12.66
		Mean consumption /Hr+ SD	10.66+6.02	13.66+5.68	19.00+13.89	14.44 +4.22

fish species revealed interesting information. Both *Channa stewartii* (Murrels) and *Danio aequipinnatus* were found to be the most efficient consumer of mosquito larvae in comparison to other three fish species tested under the study. They are followed by *Colisa, Rasbora* and *Mystus* species under the captive condition.



All these five fish species are also known as the potential ornamental fishes of northeast India (Das2005). Of these *Channastewartii* (Murrels) and *Danioaequipinnatus* are in great demand in the international ornamental fish markets. At present,only the wild caught varieties are sent to the global market. Therefore, there is an urgent need to create awarenesson conservation of these native fish species through aquaculture where mosquito larvae can be utilized as one of the important low-cost feed. Efficient utilization of mosquito larvae by these fishes shall not only aid in control of mosquito but also encourage culture of these important varieties of indigenous fishes of ornamental value.

REFERENCES

Gratz NG, Pal R (1988). Malaria vector control: larviciding. In: Wernsdorfer WH, McGregor I(eds) Malaria: Principles and practice of malariology. Edinburgh, UK: Churchill Livingstone, pp 1213-26

Hurlbert SH, Mulla MS (1981). Impactsof mosquitofish (*Gambusia affinis*) predation on plankton communities. Hydrobiologia 83: 125-51

BenceJR (1988). Indirect effects and biological control of mosquitoes by mosquitofish. J Appl Ecol 25: 505-21

Walton WE (2007). Larvivorous fish including Gambusia. In Biorational Control of Mosquitoes. Published by the American Mosquito Control Association 23(2): 184-220

Kim HC, Kim MS, Yu HS (1994). Biological control of vector mosquitoes by the use of fish predators, *Moroco oxycephalus* and *Misgurnus anguillicandatus* in the laboratory and semi field river paddy. Korean J Entomol24: 269-84

Bhattacharjee I, Gautam A, Goutam C (2009). Laboratory and field assessment of the potential of larvivorous, air-breathing fishes as predators of culicine mosquitoes. Biological Control Volume 49(2): 126-133

Rehage JS, Barnetti BK, Sih A (2005). Foraging behavior and invasiveness: do invasive Gambusia exhibit higher feeding rates and broader diets than their noninvasive relatives? Ecology of Freshwater Fish 14: 352-360

Sharma VP, Ghosh A (1994). Larvivorous Fishes of Inland Ecosystem NIMR, New Delhi, India

Chandra G, Bhattacharjee I, Chatterjee SN, Ghosh A (2008). Mosquito control by larvivorous fish. Indian Journal of Medical Research 127: 13-27

Manna B, Aditya G, Banerjee S (2008). Vulnerability of the mosquito larvae to the guppies (*Poecilia reticulata*) in the presence of alternative preys.Journal of Vector Borne Diseases 45: 200-206

MenonAGK (1991). Indigenous Larvivorous Fishes of India.NIMR, New Delhi, India

Morton RM, Beumer JP, Pollock BR (1988). Fishes of a subtropical Australian saltmarsh and their predation upon mosquitoes. Environmental Biology of Fishes 21: 185-194

NengW, Shusen WH, Guangxin X, Rongman, Guangkun T, Chen Q (1987). Control of Aedesaegypti larvae in household containers by Chinese cat fish.Bulletin of the World Health Organization 65: 503–506

Das SK (2005). Assam - A Potentially Rich Source of Ornamental Fish for the International Markets. Aqurarma magazine, Singapore, Issue 5, pp25-26

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