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Correlates of school going children's calorie consumption and nutritional level in Mizoram

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ABSTRACT

Across the world, the problem of malnutrition has been perceived as the most dangerous and menacing factor towards ensuring a decent and secure livelihood. The problem of malnutrition has got social, political, technical and motivational dimensions as well. Education being the basic driving force for any economy and process per se, the school going children need to be focussed and attended comprehensively so that they can grow up themselves as healthy citizens having belligerent mind and body. The available research findings on child nutrition has proved that nutrition is basically a complex phenomenon and cannot be managed in a single intervention. Accordingly the present study was conceptualised with an aim to identify the correlates of school going children's calorie consumption and nutritional level. The nutrition has been conceived as a composite configuration of food intake, calorie intake, high value food intake, sanitation and total calorie consumption. The study was conducted at Champhai district of Mizoram. It depicts that the predictor variables like age, training, family size, subsidiary income, parents education, crop yield, etc. have become predominant factors in making a discernable difference between high and low level of nutrition status among the respondents.

Keywords: Calorie consumption, child nutrition, food intake and malnutrition

Malnutrition is not only a biological phenomena, it is a synergy of biophysical as well as social process. Access to sufficient and nutritionally rich food is also one of the discerning factors that impacts heavily on the nutritional aspects on the school children. The analysis of malnutrition thus needs a complex framework encompassing all the cognate factors like size of holding, parental education, food intake volume, energy intake, chronological age, ill behaviour of agriculture, information seeking behaviour, medical and health care and so on. Malnutrition has a dampening effect on their growth potential particularly during their spurt period (Gill *et al*, 2008). It had also been studied that nutrition knowledge level of mothers significantly affects the nutritional status of their children. (Chandna and Sehga, 1995). The educational performance is a strong and illustrative component of nutritional management and nutritional level of school going children. The level of nutrition figures up the mental alertness, physical fitness and motivational preparedness of a child in a teaching learning environment. The nerve cells are operationally and functionally supported by nutritional supplements which would ultimately help build up analytical acumen and passionate expression within a child. Under this research perspective the present study was formulated with an aim to identify the correlates of school going children's calorie consumption and nutritional level.

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MATERIALS AND METHODS

Purposive multi stage random sampling methods was followed to select eighty number of respondents in the present study. The respondents belonged to the age group of 6 – 14 years attending the primary school and middle school level. So far as the gender is concerned 50% of them are boys and 50% of them are girls. The data were collected from four localities of Champhai district of Mizoram. The data were subjected to correlation, path and discrminant analysis to extract otherwise hidden information.

RESULTS AND DISCUSSION

The co-efficient of correlation presented in table-1 shows that none of the variable has recorded significant correlation that does not necessarily mean that the interactive relationship between the variables have got no social implication. This variable might have recorded a significant relationship given the level of significance has been fixed at 10 or 20% that is why some of the variables(3) in order of coefficient of correlation value have been selected for discussion. Family size have recorded perceptible relationship with the total calorie consumption which indicates that as there is integration of resources and capability in a large family, the food intake volume and high value food intake of respondents is higher which ultimately leads to the higher calorie consumption of the respondents. The other two variables in order of relationship which has come up to the tally are subsidiary family income and training.

Table 1: Co-efficient of Correlation between total calorie consumption and twelve independent variables

Variables	r value
Age(X_1)	0.03
Education(X_2)	-0.01
Parents Education(X_3)	-0.02
Family size (X_4)	-0.19
Size of Homestead Land (X_5)	-0.06
Size of Cultivable Land (X_6)	-0.01
Family Income[Agri.] (X_7)	-0.06
Family Income[Subsidiary.] (X_8)	0.07
Total Family Income (X_9)	-0.00
Total Crop Yield (X_{10})	-0.02
Home Consumption (X_{11})	-0.01
Training(X_{12})	0.11

*Note: *r ≥ 0.220 are significant at P = 0.05*

Table-2 shows that the variable age and education have recorded significant and positive correlation with nutritional status. This indicates that respondents of higher age and higher education ultimately have higher nutritional status than those with lower age and lower education. This is because with the increase in age their demand for food is higher, as they consume more food their calorie consumption grows higher which ultimately leads to higher nutritional status.

Table 2: Co-efficient of Correlation between nutritional level and twelve independent variables

Variables	r value
Age(X_1)	0.83**
Education(X_2)	0.77**
Parents Education(X_3)	0.01
Family size (X_4)	0.09
Size of Homestead Land (X_5)	0.00
Size of Cultivable Land (X_6)	0.05
Family Income[Agri.] (X_7)	0.01
Family Income[Subsidiary.] (X_8)	0.02
Total Family Income (X_9)	-0.01
Total Crop Yield (X_{10})	0.13
Home Consumption (X_{11})	0.14
Training(X_{12})	-0.14

*Note: *significance of r at 5% = >0.220, **significance of r at 1% = >0.287*

Table-3 shows that age has recorded the highest direct effect followed by education and family size. Age and education too have recorded substantive indirect effect followed by family income. But so far as total effect is in concern none of the variables has recorded a significant level of impact. However, based on the degrees of impact family size has recorded highest effect on the total calorie consumption level. The residual effect here has been found to be too high. It indicates that the spurious effect has superseded fairly the amount of explicable variability embedded with the interactive relationship of these exogenous and endogenous variables.

Table-4 shows that the direct effect of age on nutritional status has so far been the highest followed by size of homestead land and family income through agriculture. In determining nutritional status of the children along with age the other important considerations are size of homestead land and family income through agriculture. So, modernization of agriculture as well as effective management of homestead land both would be imparting on the nutritional level being achieved by the children. The residual effect is just only 27.76% to conclude that around 72% of the total variability embedded with the consequent variable has been successfully explained by having the combination of 12 exogenous variables.

Figure-1 reveals that the variable age has got the highest discriminatory function in creating variation of total calorie consumption among the respondents. It has been followed by other two variables, training and education of the respondents. So, these three variables in order of importance might be conceived while management strategy will be taken out to ensure the total calorie consumption level of the respondents.

Figure-2 reveals that the variable age has got the highest discriminatory function in creating variation of nutritional status among the respondents. It has been followed by other two variables, education and agriculture income. So, these three variables in order of importance might be conceived while management strategy will be taken out to ensure the level of nutritional status among the respondents.

The entire research study on child nutrition has proved that the nutrition is basically a complex phenomena and cannot be managed in the single intervention, it's not been a single chance factor either. In this study, the nutrition has been conceived as a composite configuration of food intake, calorie intake, high value food intake, sanitation and total calorie intake. It depicts that the predictor variables like age, training, family size, subsidiary income, parents education, crop yield, etc. have become predominant factors in making a discernable difference between high and low level of nutrition status among the respondents.

Table 3: Path analysis: Total calorie consumption and twelve exogenous variables

Variables	Direct effect	Indirect effect	Total effect	Substantial indirect effect I	II	III
Age(X_1)	0.4077	-0.3763	0.0314	-0.3529 (X_2)	-0.023 (X_{12})	-0.0077 (X_4)
Education(X_2)	-0.3745	0.3635	-0.011	0.3842 (X_1)	-0.0231 (X_{12})	0.006 (X_5)
Parents Education(X_3)	0.0188	-0.0339	-0.0151	-0.0439 (X_4)	-0.0237 (X_1)	0.0186 (X_2)
Family Size (X_4)	-0.2038	0.0143	-0.1895	-0.0277 (X_7)	0.0154 (X_1)	0.0127 (X_{10})
Size of Homestead Land (X_5)	-0.0362	-0.0214	-0.0576	-0.0659 (X_1)	0.0622 (X_2)	-0.0497 (X_4)
Size of Cultivable Land (X_6)	0.0382	-0.0448	-0.0066	-0.0538 (X_4)	-0.0241 (X_5)	0.0174 (X_{12})
Family Income[Agri.] (X_7)	-0.0566	0.002	-0.0546	-0.0998 (X_4)	0.0406 (X_{12})	0.0266 (X_9)
Family Income[Subsidiary.] (X_8)	-0.0159	0.0854	0.0695	0.0891 (X_4)	-0.0642 (X_2)	0.0403 (X_1)
Total Family Income (X_9)	0.0373	-0.0395	-0.0022	-0.0403 (X_7)	-0.032 (X_2)	0.0317 (X_{12})
Total Crop Yield (X_{10})	0.0295	-0.0516	-0.0221	0.0454 (X_{12})	-0.0454 (X_7)	0.0424 (X_1)
Home Consumption (X_{11})	-0.0154	0.0052	-0.0102	-0.0476 (X_4)	0.0388 (X_{12})	-0.0261 (X_7)
Training(X_{12})	0.1228	-0.0159	0.1069	-0.0764 (X_1)	0.0704 (X_2)	-0.0187 (X_7)

Residual effect: 0.9284

Table 4: Path analysis: Nutritional level and twelve exogenous variables

Variables	Direct effect	Indirect effect	Total effect	Substantial indirect effect I	II	III
Age (x_1)	0.9212	-0.0952	0.826	-0.0573 (X_2)	-0.0324 (X_5)	-0.0114 (X_8)
Education (x_2)	-0.0608	0.8342	0.7734	0.8680 (X_1)	-0.0333 (X_5)	-0.0197 (X_8)
Parents Education (x_3)	0.0348	-0.0225	0.0123	-0.0534 (X_1)	0.0471 (X_9)	-0.0442 (X_8)
Family Size (x_4)	-0.0008	0.0925	0.0917	-0.0607 (X_7)	0.0502 (X_8)	0.0489 (X_5)
Size of Homestead Land (x_5)	0.2007	-0.0812	0.1195	-0.0782 (X_6)	-0.0328 (X_9)	-0.0311 (X_1)
Size of Cultivable Land (x_6)	-0.1177	0.1658	0.0481	0.1334 (X_5)	0.0263 (X_8)	0.0150 (X_{11})
Family Income [Agri.] (x_7)	-0.124	0.1376	0.0136	0.0868 (X_9)	0.0533 (X_{11})	0.0307 (X_8)
Family Income [Subsidiary.] (x_8)	-0.1149	0.1297	0.0148	0.0911 (X_1)	0.0526 (X_9)	-0.0299 (X_{11})
Total Family Income (x_9)	0.1218	-0.13	-0.0082	-0.0884 (X_7)	-0.0540 (X_5)	-0.0496 (X_8)
Total Crop Yield (x_{10})	0.0012	0.1331	0.1343	-0.0996 (X_7)	0.0959 (X_1)	0.0784 (X_{11})
Home Consumption (x_{11})	0.1155	0.0232	0.1387	-0.0572 (X_7)	0.0298 (X_8)	0.0285 (X_9)
Training (x_{12})	-0.0126	-0.1221	-0.1347	-0.1725 (X_1)	-0.0411 (X_7)	0.0365 (X_{11})

Residual effect: 0.2776

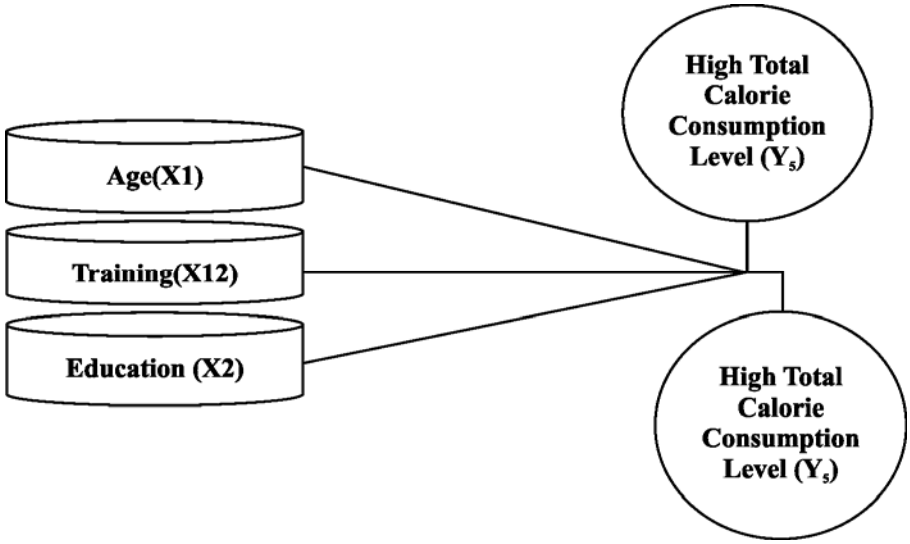

Fig. 1: Discriminant analysis: Total calorie consumption and twelve independent variables

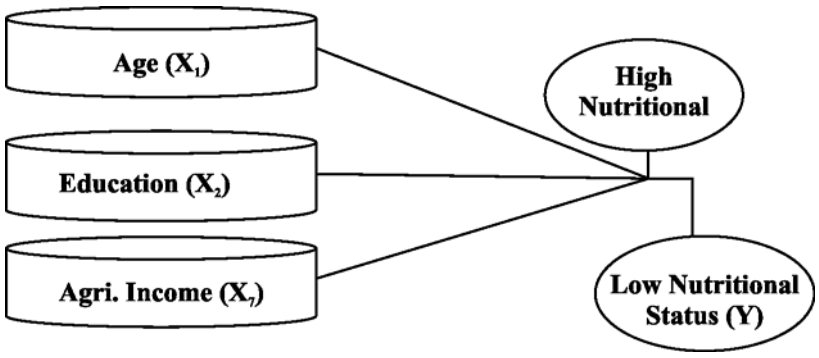

Fig. 2: Discriminant analysis: Nutritional level and twelve independent variables

Some important indicators however are missing from the study and these are Body Mass Index (BMI), haemoglobin level in blood and anaemic level and other disease frequency and vulnerability level. There are elements of contradictions between amounts of food consumed and calorie intake, proportion between common food and high value food, explicit hunger and implicit hunger and so on. In near future, the earth population will be hungrier and the hunger map will keep swallowing almost 80% of the geographical area. Every new nation against every month will be joining the row of hungry nations. The climate change and global warming are exerting more and more stress of the productive behaviour of different crops, fishes and animal resources too. That's why the present research is leaving behind threads of future research for modelling a resilient system towards managing malnutrition and confronting the challenges of hunger, poverty and voiceless ness.

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Structural transition in Karnataka Agriculture during post liberalization era

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ABSTRACT

Cropping pattern connotes the crop-mix grown in a particular area in an agricultural year. The transitions in cropping pattern are usually brought by complex gamut of factors. The study on these changes is vital in adjusting research priorities accordingly. Time series met a data on area under various field crops in Karnataka state forms the data base for empirical analysis. Ratios such as location quotient and crop versatility index were used to assess the extent of transition. The results of the study revealed that the specialized crops in particular parts of the state with high magnitude of location quotient. Crop versatility index reflected that most of the traditional staple food crops have become more versatile in terminal period of the study. Based on the degree of versatility of the crop, development of desired infrastructural facilities needs to be taken.

Key words: Cropping pattern, crop versatility index, and location quotient

Karnataka's agriculture has undergone sea changes in past decade due to a complex gamete of factors. One of the vital factors responsible for this change can be attributed to the crop diversification. Crop diversification is an approach, which aimed at maximized use of land, water and other natural resources for the development of agricultural sector in the country. It provides the farmers with practicable and possible options to grow different crops on their land. The diversification in agriculture serves as a coping mechanism against risk and uncertainty arising out of climatic and biological vagaries. Cropping pattern determines the output mix in a particular region. Cropping pattern refers to adoption of particular type of crops by the farmers in a particular region. A change in cropping pattern implies a change in proportion of area under different crops. It has significant bearing on widening the geographical inequalities in income distribution.

The development and adoption of new agricultural technologies have a significant influence on the crop-mix which is more prominent in agriculturally developed regions. A dynamic change has been witnessed in agricultural sector in the state, particularly during post-green revolution and post liberalisation period. The technological advancement in crop varieties and other yield increasing factors of production are hypothesised to have influence on farmers' behaviour which have been reflected in the changing cropping pattern from cultivation of low value crops to high value crops in most parts of the state.

The true reflection of diversification is the wide variety of crops being grown in different seasons in different parts of Karnataka. The major crops grown are paddy covering 14.16 lakh ha, ragi 8.32 lakh ha, jowar 13.82 lakh ha, bajra 4.32 lakh ha, maize 11.13 lakh ha, wheat 2.76 lakh ha, minor millets 0.36 lakh ha. Totalling the area under cereal crops was around 54.87 lakh ha. The area under major pulses was about 23.85 lakh ha. Of which the area sown under Bengal gram was about 6.05 lakh ha and red gram about 6.81 lakh ha. The area under major commercial crops such as groundnut, cotton, and sugarcane was about 9.08 lakh ha, 4.03 lakh ha and 3.06 lakh ha respectively (Karnataka State at a Glance, 2008-09). The study of transition in cropping pattern is of immense importance in designing and formulating various policies related to agricultural growth and development.

MATERIALS AND METHODS

To accomplish the objective, simple ratios and indices which better reflect the changes in spatial distribution of crops along with their relative importance in each district of Karnataka were computed. To have dynamism, the total study period of ten years was divided into two quinquinnial sub periods. The first quinquinnium was regarded as the base period (1997-2001) and the second quinquinnium was regarded as the terminal period (2002-2006). To have uniformity of the data, which is crucial, the districts considered for the base period should be the same as in the terminal period, the two quinquinneal periods from 1997 and from 2002 are considered for 27 districts of Karnataka. During the terminal period of analysis, agricultural years of 2002, 2003 and 2004 are regarded as drought periods. The remaining years *i.e.*, 2005 and 2006 of the terminal period are considered as normal years. The hypothesis behind the choice of two periods is to examine the consistency in the performance of agriculture between the two periods.

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The Meta data on area under major annual field crops was obtained from the various published reports of Directorate of Economics and Statistics (DES). Only those annual field crops occupying more than 5 per cent of the cultivated area were included in the analysis. The areas of vegetable crops and fruit crops were not included in the analysis due to want of data. The area under plantation crops is not included in the analysis mainly because of their very nature of location specificity and they will not attract similar attention as in the case of annual crops in terms of policies, programmes and institutional arrangements.

Methodology

To analyze the performance of the selected field crops, simple measures like percentages, ratios, rank correlations, coefficient of concordance, computation of location quotient, crop versatility index were employed. The details of analytical tools are summarized below, (Ranganatha, 1983)

Location Quotient

To assess the relative importance of different crops in the different districts, location quotient was computed. The degree of specialization of the crops in the district is reflected in the magnitude of the quotient. Location quotient of a quotient more than unity is considered as an index of specialization of the particular crop in the district.

Location quotient was worked out using the following formula.

$$LQ_{ij} = \frac{A_{ij}}{A_j} / \frac{A_i}{A}$$

Where, LQ_{ij} = Location quotient of i^{th} crop in j^{th} district, i = 1,2,.....15 and j = 1,2, ...,27

A_{ij} = Area of the of i^{th} crop in j^{th} district,

A_j =Gross cropped area in the j^{th} district

A_i = Area of the i^{th} crop in the state

A =Gross cropped area in the state,

Thus,

$$LQ_{ij} = \frac{\text{Percentage area of the } i^{th} \text{ crop in } j^{th} \text{ district to the Gross cropped area in the } j^{th} \text{ district}}{\text{Percentage of area of the } i^{th} \text{ crop in the state to gross cropped area in the state}}$$

Crop versatility index

The versatility index of a crop is inversely proportional to coefficient of variation among the district wise areas of the corresponding crop. Thus, more the coefficient of variation lesser is the versatility of the crop and vice-versa.

A more versatile crop is one which is grown in more number of districts with more or less same percentage of area in all the districts. The crops have been ranked based on the magnitudes of the coefficient of variation. Over the study period, if the rank of a crop increase it can be inferred that its versatility increased indicating its spread to more number of districts and tending to be of similar importance, in terms of allocation of area, in the different districts of the state.

$$\text{CV of } i^{th} \text{ crop} = \frac{\text{Standard deviation among the percentages of areas of the } i^{th} \text{ crop in 27 districts}}{\text{Mean of the district wise percentages of areas of } i^{th} \text{ crop to the total cropped area in the 27 districts}} \times 100$$

'i' ranges from 1 to 15.

RESULTS AND DISCUSSION

All the crops are not equally important in all the districts. Knowledge of specialization of crops in each district will facilitate in planning and organizing crop development activities in the districts. In addition, this is not only useful to biological scientists but also for social scientists, policy makers, and others in tackling the various aspects of crop improvement programmes. Location quotient (LQ) was computed to know the relative importance of different crops in the different districts. The magnitude of the quotient reflects the degree of specialization of crops. Crops with LQ more than unity in each of the 27 districts during different periods of the study are presented in the table1.

The LQ considers the relative position of a crop in a district with that at the state level. In case of the important dry land crop of the southern and eastern Karnataka, namely, ragi, both the acreage as well as LQ are decreased in case of Davangere, Kolar, Chickmagalur, Bengaluru rural and urban, Chitradurga and Hassan (in majority of these districts the cereal based cropping system has paved way for more profitable vegetable based cropping system which enjoys comparative advantage over the other). In case of Tumkur and Mysore district, though the area under ragi has decreased the LQ has shown an

increased trend. The result was contrasting in case of Chamarajnagar wherein the area under ragi has increased but the LQ has shown a declining trend. In case of dry land crop of Northern Karnataka, jowar, both the area and LQ has decreased in major jowar growing districts such as Bijapur, Bagalkot, Gulbarga, Gadag, and Bidar. This result clears the fact of diversification of crops in these districts. The farmers in these districts have eventually reduced their dependence on dry land crops like jowar and shifted to high value crops like grapes, sunflower and pomegranate. The other likely reason is the versatility of this crop in the state, *i.e.*, this crop is being grown even in the non- traditional areas. The trend in case of Haveri and Raichur district was bit different, wherein the area under jowar has decreased while the LQ has shown an increasing trend. In case of paddy both the area and LQ has dropped in major paddy growing districts of the state *i.e.*, Shimoga, Dakshina Kannada, Kodagu, Chickmagalur, Mandya, and Mysore. The area and LQ has shown an increasing trend in case of Davangere, Bellary and Raichur. This clearly indicates the transition in the cropping pattern from paddy crop to less labour and water intensive, relatively remunerative crops like arecanut, maize. In case of Uttara Kannada the area has decreased while the LQ has increased. The contrasting result was observed in Udupi wherein the area has increased while the LQ has dropped. The result was in accordance with the outcome indicating that the area under jowar, bajra, ragi and minor millets are experiencing a substantial annual decrement. The area under rice has recorded a mild annual increment. The growth in area under oilseeds and commercial crops was negative and insignificant (Saraswati *et. al*., 2012)

As regards sugarcane crop, it may be noticed that both the area and LQ has decreased in Chamarajnagar and Shimoga. Both the area and LQ has increased in case of Bidar district. In major cane growing areas such as Mandya, Bagalkot and Bijapur the area under cane has decreased whereas the increase in LQ was observed. Regarding ground nut crop both the area and location quotient has decreased in Kolar, Gadag and Bellary. In case of Chitradurga and Tumkur the area under crop has decreased while the LQ has shown an increasing trend. The area and LQ for the cotton crop was decreased in case of Gadag and Bellary. Whereas contrasting result was observed in Uttara Kannada where both have shown an increasing trend. The area under cotton crop has decreased, while the LQ was positive in case of Dharwad, Mysore and Belgaum. This outcome was aptly supported by the result reflecting the shift in cropping pattern in favour of maize and cotton in Northern transitional zone of Karnataka. Though this was a welcome feature in terms of profitability to farmers but it is at the cost of making the zone deficient in rice, wheat and jowar the staple food crops of the zone (Aravind, 2010).

Crop versatility can be derived from the information on the cropping pattern prevailing in the state. If a crop is region specific the development of the genetic material, availability of specialists, extension efforts, arranging services and supplies, building market services etc., are to be developed specifically for that crop with special reference to that region.(*i.e.* Location specific and demand driven research and development and extension delivery mechanism has to be adopted) On the other hand if a crop is more versatile it is necessary to develop infrastructure and other facilities keeping in view the degree of versatility of the crop. This measure is useful in the context of knowing the nature of the crop with regard to its spatial coverage in quantitative terms. The results relating to the crop versatility are presented in Table 2.

Among the food crops, despite of the fact of decline in area under jowar, it became more versatile during terminal period (its capacity to withstand and acclimatize to periodically occurring sporadic droughts and depleting ground water table has increased its spatial coverage even to non-traditional belts). Next to jowar, paddy was regarded as more versatile in both the periods besides being the fact that the area under the crop has declined. It is because of the obvious reason that the paddy is the staple food crop of the state. It was followed by maize crop which is relatively versatile among the remaining cereal food crops despite the fact of increased area under it. The maize crop is gradually replacing specialised crops of various districts because of its relative profitability, adaptability to varying agro-climatic condition, need of less farm management operations and serves as a source of feed and fodder. This outcome was in line with the results indicating that the growth rate of maize crop in terms of area and production has increased significantly and overtaken the traditional crop, and occupies largest share of area and production in the state. In this manner, the state of Karnataka, traditionally known for rice cultivation has slowly switched over to the cultivation of maize crop in the recent years. (Singha and Chakravorty, 2013)

Among the oilseed crops groundnut was found to be more versatile in both the periods. Since, it occupies a prominent place in majority of the cropping systems by virtue of its adoptability to wide soil and agro-climatic situation. With regard to sesamum, it was more versatile during base period, which has shown a tendency of getting specialized in the terminal period. Linseed was found to be more specialized crop as it is confined to the northern

districts of Karnataka and its versatility decreased marginally in the terminal period. Amongst the commercial crops the more versatile crop was found to be the cotton crop in the study period. Whereas the versatility of other commercial crops inter alia sugarcane and tobacco remained less versatile in both the periods. Sugarcane being a location specific crops demands for areas congenial soil and agro-climatic conditions and also the accessibility to processing units and transportation facilities. On the other hand to grow tobacco, special permission from the government is required. *i.e.*, it is considered as controlled crop since area under this crop is predefined .These results are at par with the actuality and theoretical expectations.

However, jowar, paddy, maize and ragi also tended to become more versatile during the terminal period. This transitional process was facilitated by the development of technology (location specific HYV and hybrids). Technologies like aerobic rice, jowar varieties for different conditions helped in breaking location specificity. The factors like productivity of the crop, ease of management, skill and knowledge of farmers, nearness to processing unit, market demand as reflected by prices of the products, own consumption need of the farmers decides allocation of area under the crops. All these factors are considered to have significant influence on versatility of crops.

The results of the study revealed that the paddy and ragi are the crops specialized in Southern and Eastern parts of the state. The crops like Jowar, wheat, Bajra, sesamum, linseed, Bengal gram, Tur and cotton are mainly specialized in Northern parts of the state. Crops like ground nut, sesamum, tobacco, sugarcane are grown in all parts of the state reflected their versatile nature. Knowledge of specialization of crops is a prerequisite for biological and social scientists as well as for the policy makers in planning, organizing and executing various crop improvement programmes. The transitional process in cropping pattern was observed among the traditional staple food crops like paddy, jowar etc. Technologies like aerobic rice, location specific high yielding varieties and hybrids helped in breaking specialisation. The factors like productivity of the crop, ease of management, skill and knowledge of farmers, nearness to processing unit, market demand as reflected by prices of the products, own consumption need of the farmers have a significant bearing on versatility of the crops. The future line of work is to study the relative impact of these factors on transition in the cropping pattern.

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Table 1: Location quotient

Particlars	Crops specialized only in the base period		Crops specialized only in the terminal period		Crop specialized in both base and terminal period		LQ(+)	LQ(-)
District	**Area(+)**	**Area(-)**	**Area(+)**	**Area(-)**	**Area(+)**	**Area(-)**	**LQ(+)**	**LQ(-)**
Bengaluru Urban						Ragi		Ragi (5.38)
Bengaluru Rural						Ragi		Ragi (4.63)
Chitradurga		Sunflower			Maize, Sesamum	Ragi, Groundnut	Groundnut (4.06), Sesamum (1.45)	Ragi (1.39), Maize (1.25)
Davangere	Tobacco	Sugarcane			Paddy, Maize		Paddy (2.22), Maize (4.21)	
Kolar						Ragi, Groundnut		Ragi(3.26), Groundnut (1.88)
Shimoga		Sugarcane			Maize	Paddy, Sugarcane	Maize (3.81)	Paddy (4.81), Sugarcane (1.44)
Tumkur				Paddy		Ragi, Groundnut	Ragi (6.98), Groundnut (7.74)	
Belgaum			Groundnut, Bajra	Jowar	Maize, Wheat, Bengal gram	Linseed, Sugarcane, Cotton, Tobacco	Maize (5.68), Wheat (11.91), Linseed (5.20), Sugarcane (19.94), Cotton (3.28), Tobacco (9.82)	
Bijapur					Bajra, Wheat, Bengal gram	Linseed, Sunflower, Jowar	Sunflower (3.01)	Jowar (1.87), Wheat (2.50), Bengal gram (1.62), Bajra (2.39), Linseed (3.81)
Bagalkot		Bengal gram			Maize	Jowar, Bajra, Wheat, Linseed, Sunflower, Sugarcane	Bajra (2.04), Linseed (6.24), Sugarcane (4.13)	Jowar (2.04), Wheat (1.81), Maize (1.10), Sunflower(2.19)
Dharwad			Groundnut	Jowar	Bengal gram	Wheat, Cotton	Wheat (4.19), Cotton (4.51)	Bengal gram (1.75)
Gadag					Wheat,	Jowar, Maize, Bengal gram, Groundnut, Wheat, cotton Sunflower	Linseed (1.88)	Jowar (1.21), Maize (3.53), Bengal gram (1.52), Groundnut (1.47), Sunflower (1.59), Cotton (2.84)
Haveri	Paddy	Wheat			Maize	Jowar, Cotton	Jowar (1.19), Maize (3.54), Cotton (4.24)	

Table 1. Contd.

District	Area(+)	Area(-)	Area(+)	Area(-)	Area(+)	Area(-)	LQ(+)	LQ(-)
Uttara Kannada					Cotton	Paddy	Paddy (6.26), Cotton (2.02)	
Bidar					Tur, Sugarcane	Jowar, Bengal gram, Sesamum	Tur (3.37), Sugarcane (1.99)	Jowar (1.58), Bengal gram (1.72), Sesamum (1.65)
Bellary					Paddy, Maize, Bajra, Sesamum	Groundnut, Sunflower, Cotton	Paddy (1.51), Maize (1.65), Bajra (1.26), Sesamum (1.42)	Cotton (1.44), Groundnut (1.72), Sunflower (1.65)
Gulburga		Linseed	Sesamum	Sunflower	Bengal gram, Tur	Jowar, Bajra	Bajra (1.59), Tur (5.53)	Jowar (1.59), Bengal gram (1.77)
Raichur					Paddy, Bengalgram	Jowar, Bajra, Sesamum, Sunflower, cotton	Paddy (2.49), Jowar (2.09), Bajra (4.18), Bengal gram (5.88), Sesamum (1.34), Sunflower (3.96), Cotton (1.47)	
Koppal	Linseed	Paddy, Jowar, Groundnut, Cotton			Bajra, Sesamum	Sunflower	Bajra (5.58), Sesamum (3.25), Sunflower (1.47)	
Chickmagalur						Sesamum. Paddy, Ragi	Sesamum (2.33)	Paddy (1.29), Ragi (2.05)
Dakshina Kannada						Paddy		Paddy (1.29)
Udupi					Paddy			Paddy (4.03)
Hassan	Paddy				Tobacco	Ragi,Sesamum	Tobacco (2.30)	Ragi (2.75), Sesamum (1.11)
Kodagu						Paddy		Paddy (2.15)
Mandya			Sesamum			Paddy, Sugarcane. Ragi	Ragi (2.34), Sugarcane (2.91)	Paddy (2.48)
Mysore						Ragi, Paddy, Cotton	Ragi (6.81), Cotton (3.03), Tobacco (15.63), Sesamum (2.64)	Paddy (1.90)
Chamarajnagar		Cotton		Groundnut	Ragi, Maize	Sugarcane	Maize (1.53)	Ragi (1.36), Sugarcane (3.03)

Note: - + Increase, -Decrease, Numerical figures in the parenthesis indicates Location Quotient (LQ) values in the terminal period.

Table 2. Crop versatility during the base and terminal periods

Sl No.	Crops	Base period			Terminal period		
		Gross area in the state in thousand ha	Coefficient of variation of the percentage	Rank	Gross area in the state in thousand ha	Coefficient of variation of the percentages	Rank
	Food crops						
1	Paddy	1456.71	106	3	1288.28	111	2
2	Ragi	996.60	143	9	1060.74	144	8
3	Jowar	1835.62	108	4	1559.21	102	1
4	Bajra	542.75	175	11.5	379.12	197	12
5	Maize	595.87	131	7	955.20	127	6
6	Wheat	265.52	175	11.5	251.38	184	11
7	Bengal gram	308.22	140	8	638.66	125	5
8	Tur crop	522.08	197	13	575.94	226	14
	Oil seed crops						
9	Ground nut	1137.95	105	2	861.28	114	3
10	Linseed	19.29	211	14	13.28	215	13
11	Sesamum	99.78	104	1	98.26	115	4
12	Sunflower	601.68	123	5.5	916.69	147	9
	Other crops						
13	Sugar cane	374.30	145	10	237.81	161	10
14	Cotton	567.98	123	5.5	368.35	143	7
15	Tobacco	76.53	329	15	98.74	380	15

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Allelopathic action of *Rauwolfia tetraphylla* L. root extracts on gram (*Cicer arietinum* L.) seeds

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ABSTRACT

Allelopathy refers to the advantageous or detrimental effects of one plant on another plant by liberating the chemicals from its components through leaching, root exudation, volatilization, residue decomposition and others in natural and agricultural systems. The present study has been made to appraise the allelopathic action of Rauwalfia tetraphylla L. touching to the alteration of germination, exaggeration of seedling and biochemical actions in gram seed (Cicer arietinum L.). Various concentrations of (12.5, 25, 50, 100, 150, and 200mg ml^{-1}) aqueous extracts were prepared from root of R. tetraphylla L. and germination studies were conducted. The medium concentrations (50mg ml^{-1} and 100mg ml^{-1}) of root extracts stimulated the seed germination, growth and biochemical constituents (total sugar, protein, amino acid and DNA and RNA concentrations) of gram. In higher concentrations a more or less stagnant nature was observed in all the parameters after T_4. A significant variation is found among all treatments considering seedling parameters where, seed treatment is always better than control. In biochemical observations, the view is more or less same where T_4 (100mg ml^{-1}) is indicating highest performance excepting fresh and dry weight. The enhanced action in occurrence of root extract can be supportive for early establishment of seedlings especially in water stress location. Therefore, the said treatment can be considered as an invigoration treatment under seed/crop production programme.

Keywords: Allelopathy, biochemical, gram and *Rauwolfia tetraphylla*

Bengal gram or chickpea or gram (*Cicer aritinum* L.) is one of the significant pulse crops inn India. It ranks 5th among grain crops (Smithson *et al*., 1985), and is imperative due to its high nutritive contribution in Indian diet representing the 100g of seed contains 357 calories, 4.5-15.69% moisture, 14.9-24.6g protein, 0.8-6.4 % fat, 2.1-11.7g fiber, 2-4.8g ash, 140-440mg Ca, 190-382mg P, 5.0-23mg Fe, 0.21-1.1mg thiamine, 0.12-0.33mg riboflavin, and 1.3-2.9mg niacin (Duke, 1981; Huisman and van der Poel, 1994). In 2007-08, India produced 5.75 million tonnes considering the average productivity 1448kg ha^{-1} (Fresh Portal Pvt. Ltd.). But the efficiency in India is far behind as compared to world productivity. So there is a tremendous scope for enrichment of Gram seed production in our region. In farming of this significant crop, the efficiency is deteriorated due to extreme scarce of quality seed. Seed quality may adversely be affected as a result of early desiccation resulting in high levels of green immature and smaller seed, seed- coat cracking under several wetting and drying cycles or during harvesting and handling processes. To modify the seed quality in terms of seed vigour and viability, several works have been done.

The aim of the present work is to evaluate the effect of an important responsive botanicals for enhancement of seed strength through seedling set up as well as seedling vigour which can reflects its ultimate effect in productivity more specifically on quality seed progress. The root extract of *Rauwalfia tetraphylla* L., a small much-branched woody shrub, contains the alkaloid rauvolscine in 0.1%. The dry root bark is used for medicinal purpose in small dose. The extract of root has been used as allelopathic treatment on some crops for invigoration of the seedlings (Ghayal *et al.* 2011). Therefore, it is considered as a priming treatment object for invigoration of gram (*Cicer aritinum* L.) seeds.

MATERIALS AND METHODS

The roots of matured plant of *Rauwolfia tetraphylla* were collected from the field of Bidhan Chandra Krishi Viswavidya and the extraction procedure was carried out in RKVY laboratory, Department of Seed Science and Technology. The amount of 5g root was extracted in distilled water to attain 10 ml in ultimate. The extract was centrifuged at 5000 rpm for 15 minutes and the supernatant was collected (500mg ml^{-1}). From this extract the treatments were prepared into 6 different concentrations like 12.5mg ml^{-1} (T_1), 25mg ml^{-1} (T_2), 50mg ml^{-1} (T_3), 100mg ml^{-1} (T_4), 150mg ml^{-1} (T_5), and 200mg ml^{-1} (T_6).

Gram seeds (cv. B-108) were surface sterilised by 0.1% $HgCl_2$ for 2 minutes and then they were repeatedly washed by distilled water. After that, the seeds were treated for overnight by the said treatments including normal water (C) as control. Then the seeds were evaluated through Glass-Plate method (Chakraborti, 1994) under 3 replicated aseptic condition considering germination percentage in first count, root-shoot length, fresh wt., dry wt. (100°C for

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24hrs.), vigour index etc. as seedling parameters at 7th and 14th day. The biochemical characters like total soluble sugar (Gready *et al.*, 1950), soluble protein (Lowry's method), total amino acid content (Moore and Stein, 1948), DNA and RNA (Chowdhury and Chatterjee, 1977), were estimated on 14-days old seedlings (day of final count of gram) which is considered as ultimate day for utilization of food reserves. The statistical calculations were done through Completely Randomized Design (CRD). The outcome was achieved at 5% level of significance by using MS Excel.

RESULTS AND DISCUSSIONS

The results of Table-1, indicated that the higher concentrations of aqueous root extract of *R. tetraphylla* amplified the germination percentage of *C. arietinum* seed at the day of initiation of germination connecting to active participation in germination system though after T_4 it was abruptly reduced. Obviously, the rate was slower in later days though it maintained insignificant value of germination at the end (average) excepting in T_6 and control. The observation on first count at germination can also considered as seed vigour which was very much supportive to seedling establishment in field.

Table-1: Effect of *R. tetraphylla* root extracts on gram seed germination

Treatments	Seed germination (%)			
	3rd day	4th day	5th day	Total
Water	71.40	10.70	7.08	89.18
T_1	75.40	12.50	3.80	91.70
T_2	80.56	9.06	4.07	93.69
T_3	83.60	7.03	3.10	93.73
T_4	87.30	5.20	1.27	93.77
T_5	78.70	5.60	5.80	90.10
T_6	72.20	10.50	6.40	89.10
SEm (±)	**0.75**	**0.30**	**0.07**	**0.53**
LSD (0.05)	**3.16**	**1.25**	**0.29**	**2.22**

The representing seedling characters in Table-2 indicated that the length of root as well as shoot was increased with higher concentration of aqueous solution (root extract of *R. tetraphylla*) up to T_4 in both 7 and 14 days; which showed insignificant afterwards. The ratio of root and shoot indicated the rapid growth of root in alliance with root extract at 7th day while this association at 14th day clearly indicated higher growth rate of shoot than control. But longer seedling clearly indicated the superior 'vigour index' where maximum effect came from last three concentrations of root extract, maintaining an insignificant variation at last two stages.

Table 2: Effect of *R. tetraphylla* root extracts on seedling parameters of gram

Treatments	At 7th day				At 14th day			
	Root length (cm)	Shoot length (cm)	Root: shoot	Vigour index	Root length (cm)	Shoot length (cm)	Root: shoot	Vigour index
Water	4.55	4.14	1:0.91	774.97	8.5	4.9	1:0.58	1195.91
T_1	4.59	4.19	1:0.91	805.13	8.6	4.9	1:0.57	1237.95
T_2	5.10	4.50	1:0.88	900.34	9.2	5.0	1:0.54	1331.82
T_3	5.30	5.00	1:0.94	966.45	9.25	6.5	1:0.7	1477.82
T_4	5.80	5.20	1:0.9	1041.50	10.76	7.0	1:0.65	1665.34
T_5	5. 82	5. 12	1:0.88	985.70	10.84	7.2	1:0.66	1625.41
T_6	5.70	5.14	1:0.90	965.85	10.8	7.1	1:0.66	1594.89
SEm (±)	**0.07**	**0.04**	**--**	**7.94**	**0.12**	**0.07**	**--**	**13.64**
LSD (0.05)	**0.30**	**0.15**	**--**	**33.41**	**0.49**	**0.28**	**--**	**57.44**

The similar trend was also observed in Table-3 indicates that the higher concentration of aqueous extracts of *R. tetraphylla* boost the fresh and dry weights of the sample due to greater accumulation of dry matter in healthy seedlings. But it was contrasting that the accumulation of dry matter was rising significantly with higher concentration in a continuous way excepting in an insignificant nature in last two cases at 7th day of fresh wt. similar to insignificant nature of last three treatments of other seedling parameters (Table 2).

Table 3: Effects of *R. tetraphylla* root extracts on seedling weight of gram

Treatments	Fresh weight (g)		Dry weight (g)	
	7th day	14th day	7th day	14th day
Water	0.49	1.18	0.03	0.06
T_1	0.50	1.18	0.03	0.06
T_2	0.52	1.23	0.03	0.06
T_3	0.55	1.24	0.04	0.06
T_4	0.59	1.26	0.04	0.06
T_5	0.62	1.29	0.04	0.07
T_6	0.64	1.32	0.04	0.07
SEm (±)	**0.006**	**0.004**	**0.001**	**0.001**
LSD (0.05)	**0.026**	**0.015**	**0.002**	**0.002**

The total soluble sugar content constructed an increasing trend with raising the concentration of root extract of *R. tetraphylla* though last three concentrations 100mg ml^{-1} (T_4), 150mg ml^{-1} (T_5), and 200mg ml^{-1} (T_6) showed insignificant (Table 4). The last three treatments were indicating the synthesis of more carbohydrate in rapid way in contrast to other may be due to the activity of hypogeous cotyledon in *exalbuminous* seed where it adapted for both storage and photosynthesis (Marshall and Kozlowski, 1976). The same trend was also observed in the content of protein and amino acid *i.e.*, the higher inclination was observed with higher concentrations of root extract up to T_4. This may be due to the additional synthesis of the protein material as well as amino acid responsible for cellular activity closely related to the seedling growth at their final day of count (14 days) under last three concentrations of root extract.

In estimation of DNA, the rate was insignificant while in RNA content, the trend was increasing up to T_4. In later stages, the inclination was negative may be due to condensed rate of cell division in formation of growth of root and shoot.

Table 4: Effects of *R. tetraphylla* root extracts on activity of bio-molecules (at 14th day) of gram

Treatments	Total soluble sugar (µg mg^{-1})	Soluble protein (µg mg^{-1})	Amino acid (µg mg^{-1})	DNA (µg mg^{-1})	RNA (µg mg^{-1})
Water	0.23	0.06	0.30	0.10	0.07
T_1	0.27	0.09	0.45	0.10	0.10
T_2	0.37	0.12	0.65	0.13	0.12
T_3	0.51	0.14	0.75	0.14	0.15
T_4	0.62	0.22	0.89	0.15	0.19
T_5	0.61	0.20	0.86	0.14	0.15
T_6	0.59	0.19	0.84	0.13	0.15
SEm (±)	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**
LSD (0.05)	**0.07**	**0.03**	**0.06**	**0.04**	**0.03**

The different concentration of root extracts stimulates the activity of germinating seeds which can be considered as example of allelopathy. The higher conc. was best though their activity was stagnant or decline after T_4 *i.e.* 100mg ml^{-1} except fresh and dry weight. The early germination of seed and formation of new surface root initials (lateral roots) from primary root in short duration crop is also vital with the primary root length and dry matter accumulation which may be able to reach and exploit localized patches of nutrients in the soil (Lynch, 1995), to establish the healthy seedlings. After T_4 treatment, the stagnant nature is probably due to formation of more lateral roots. But the rapid sequence of cell division for progress of morphological characters, particularly root is very much linked to various biochemical markers (Tinus *et al.*, 2000) where T_4 was the best. Therefore, T_4 or 100mg ml^{-1} can be considered as best for getting the most amplified seedlings in field establishment.

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