RESEARCH ARTICLE Legume Research- An International Journal, Volume 48 Issue 4: 714-720 (April 2025)

Genetic and Nutritional Secrets of Groundnut Varieties Unveiled for Enhancing Farmers Income by Groundnut Value Chain Process

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10.18805/LR-5318

ABSTRACT

Background: Peanut (*Arachis hypogaea* L.) is one of the most important oil seed crops. It is nutritionally and economically a high value oil seed crop and is in the sixth most important in the world. It is also known as a "Wonder legume".

Methods: Based on the physical parameters the peanut varieties were classified as high oil content (50-53%) varieties *viz.,* VRI (Gn) 5, Co(Gn)4, Co7 and low oil content (44-49%). varieties *viz.,* VRI 9, VRI10, BSR 2. Among the varieties, the best suited variety for secondary processed products namely, salted peanuts, peanut chikki, peanut butter, peanut chutney powder, masala peanut were assessed and evaluated for the nutrient composition and sensory evaluation.

Result: All the varieties exhibited good source of protein, fat, crude fiber. free fatty acid and peroxide value and confirmed to the FSSAI standards. Developed secondary processed product has excellent keeping quality. scored maximum sensory score in terms of organoleptic attributes. The higher oil content peanut varieties are recommended for oil extractionand the varieties with oil content below 50% are well suited for secondary processed products. This paper gives the detailed report of choosing the suitable groundnut variety for different secondary processing. Training cum demonstration on selecting suitable variety for different processing was imparted to the farmers in improving the value chain and to get good returns. However, a diversity of value adding options are being promoted for adoption by farmers to sustainably improve and raise farmers' household incomes livelihoods.

Key words: Farmer income, Peanut, Sensory evaluation, Value added, Variety.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) also called groundnut, is a high value crop nutritionally and economically and is the sixth most important oil seed crop in the world (FAO, 2005). It is known as a "king of oil seed and wonder legume" for its flowering, pegging and pod formation pattern (Boraiah *et al.,* 2012). In India, peanut is cultivated in an area of 5.3 m ha with the production of 9.2 mt. The average productivity of peanut is about 1300 kg/ha in India as against the world average of 1774 kg/ha. In Tamil Nadu the crop occupies area of 3,38,300 ha with a production of 7,83,200 t (Anuradha *et al.,* 2021) and in the study area of Thiruvarur district peanut is cultivated in area is 2522 ha and with a production of 7853 t. Nearly 90% of the total peanut area in India is mostly concentrated in six states, *viz.,* Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra and Rajasthan (Rathnakumar *et al.,* 2014). The *kharif* season accounts for about 80% of the total peanut production.

Peanut kernels are regarded as healthy foods as their nutrient profile is balanced (Arya *et al.,* 2016). It provides 564 kcal of energy (10-25%), carbohydrates (25-28%), easily digestible protein, a good source of minerals (Ca, P, Mg, Zn and Fe), fiber, antioxidants and vitamins (E, K and B complex) along with some biologically active polyphenols, flavonoids and isoflavones. Peanut is particularly valued for oil and protein content of 55% and 28% respectively.

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How to cite this article: Kamalasundari, S., Balasubramanian, P., Anuratha, A., Arulselvi, S., Babu, R. and Subbulakshmi, B. (2025). Genetic and Nutritional Secrets of Groundnut Varieties Unveiled for Enhancing Farmers Income by Groundnut Value Chain Process. Legume Research. 48(4): 714-720. doi: 10.18805/LR-5318.

Submitted: 07-03-2024 **Accepted:** 20-06-2024 **Online:** 30-07-2024

In India there are 117 notified varieties of peanuts (Pal *et al.,* 2021). There is a great variation in oil content within peanut sub species. The oil content ranges from 42 to 56% and plays an important role in determining

the quality parameters of many of the primary and secondary processed peanut products. Sravani *et al* . (2020) recorded that the chemical compositional properties such as protein content, oil content *etc*. are needed for deciding their suitability for development of products such as peanut butter, peanut powders, milk analogues and peanut protein isolates. Sithole *et al.* (2022) also commented that the variation in chemical and nutritional composition bring wider variation in technical suitability and specification for particular function. In primary processing the peanut kernels are dried, de-shelled. But the secondary processed products of peanut are many more *viz.,* peanut snacks such as roasted and salted nuts, peanut milk, boiled peanut, peanut butter, masala peanut nuts used in namkeens, peanut bars, nut laddu, peanut cake, de-oiled cake. Peanut flour used for varied food preparations. Indian peanuts is very popular in the international market for the table purpose due to its characteristic natural flavor, nutty taste, crunchy texture, longer shelf life and thereby better export opportunity (Ansari *et al.,* 2015).

In manufacturing of many of these secondary processed peanut products industrialists has to choose the peanut variety based on its oil content and chemical composition. Table purpose peanuts with oil content of less than 50% are best suited for production of peanut milk, peanut chikki, peanut butter, peanut laddu *etc*. If these products were prepared with high oil content varieties, oil separation occurs, the separated oil contaminates the packaging material and damage the quality and appearance (Shakerardekani *et al.,* 2013). In the same way for the extraction of peanuts oil the species having oil content of more than 50% is advisable as it gives higher yield and value. Based on their end use the manufacturer fix the price for the peanuts and plays an important role in peanut value chain. Farmers might get good revenue if the trader's preferred variety is sold as farmers sell their produce directly to commission agents. These agents reap higher values with the selection of suitable variety.

Farmers always sell freshly harvested peanuts. Hence, farmers have to be sensitized on choosing the variety based for their secondary processing. The common varieties sown by farmers was Western 44, TMV 7, CO7. They purchase the Western 44 kernels from private agency at Rs.90-100/ kg for kernel at 80 kg/acre and the kernels has oil content of less than 50 per cent. But the problem with this variety are farmers purchase these kernels from unregulated markets for cultivation and not as certified seed. Hence, there is difference in yield, for which alternate variety of VRI10 and BSR 2 with oil content of less than 50% was suggested which has the same table property.

Moreover, the farmers store peanuts as shelled and unshelled pods for different uses. Both forms are vulnerable to attack by insect pests during storage. However, peanut kernels are more susceptible to insect attack than pods in storage. The amount of damage inflicted by insect pests during post-harvest processing and storage depends on several factors such as moisture content in the product, the form in which it is stored, level of maturity at harvest, sanitation of storage space and the quality of the material itself. Hence, post-harvest managements have to be addressed to the farmers. This paper gives the detailed report of choosing the suitable ground nut variety and training the farmers in improving the value chain and to get good returns.

Materials and Methods

Field trial was conducted at Thiruvarur district, Tamil Nadu under ICAR- KVK, TNAU, Thiruvarur district, Tamil Nadu. The trial was undertaken from 2021 to 2023 (three years). Five farmers' fields were randomly selected. To create confidence on selection of varieties, farmers were sensitized on the purpose of end use, based on that six varieties was suggested *i.e.,* if the end use is secondary processing below 50% oil content varieties VRI 9, VRI10, BSR 2. If it is for oil expulsion above 50% oil content varities VRI (Gn) 5, Co(Gn)4, Co7 varieties was suggested. The demonstration of five value-added products *viz.,*salted peanuts, peanut chikki, peanut butter, peanut chutney powder, masala peanut, was prepared as per the procedure of Ansari *et al.* (2015) using table varieties and compared with western 44.

Preparation of salted nuts

Salted peanuts are prepared by soaking the peanut kernel in water with 4 % common salt for 12 hours. Soaked kernels are dried up to 50% moisture by tempering for 15 mts and then dried kernels are roasted with hot sand. Peanuts chutney powder and masala peanuts are prepared using local method. In masala peanut preparation the tempered peanuts are coated with besant flour, rice flour and spice powder marinated for 10 mts and deep fried in oil.

Preparation of peanut bars

Peanut bars are a sweet product prepared by heating clear jaggery syrup until the temperature reaches to 150°C. Immediately pre weighed roasted and dehusked groundnut was added then mixed thoroughly till the nuts get coated with jaggery syrup. Hot mass was then transferred on to a wooden board which was greased with ghee and finally packed in polythene pouches.

Preparation of peanut butter

Nut butters and nut spreads are spreadable products made from nuts that are ground into paste. Peanut butter is prepared by roasting peanuts at 160°C for 40-50 minutes and grounded to an average particle size of about 20 ìm using a food processor or blender. This process will take 4-5 minutes. At this point, the butter will start clumping together. Then add 1% salt, 2% sweetener and process for 1 to 2 minutes additionally. Continue processing the butter until it becomes completely smooth. Scrape the peanut butter into a storage container, cover and refrigerate.

Nutrients analysis

Proximate analysis for each peanut value-added products were analysed by AOAC, (2005) methods. The percentage of moisture was estimated by hot air oven method, crude protein by Kjeldahl digestion method, Soxhlet Solvent extraction method was employed for fat, acid and alkali digestion method for the crude fibre and carbohydrate was calculated by difference as reported by Ihekoronye and Ngoddy (1985). Free fatty acid and peroxide values are one the important parameters to assess the quality of oil content products.It was analysed as per AOAC procedure.

Sensory evaluation of processed products

Peanut value-added recipes were evaluated for sensory properties by 50 non trained participants for their appearance, aroma, flavor and overall impression using a nine-point hedonic scale (where 1=dislike extremely and 9 =like extremely). The tasters were also asked about their purchase intent. The cost analysis was also done.

Statistical analysis

All the analytical measurements were carried out in three replicates and results were expressed in mean values of standard deviation. The collected analytical data was analyzed by using R Software statistical tool.

Training and demonstration

Trainings and demonstrations were given to peanut growing farmers by subject matter specialist. Eight training was given to 369 farmers of peanut growing farmers of Thiruvarur district, Tamil Nadu. The hands-on training was imparted on topics of selection of suitable variety, ICM practices in peanuts, purchase of certified kernels, variety suitable for preparation of value added products, post-harvest management and cost economics calculation.

Results and Discussion

High yielding cultivars selection for cauvery delta zone

The present on farm study was conducted in three blocks of Thiruvarur district *viz.,* Needamangalam, Mannargudi and Koradachery blocks, Tamil Nadu. The trials were undertaken during 2021-2023 (three years). The results data on yield, duration days, oil content, shelling outturn, 100 kernel weights are tabulated in Table 1.

The field experiments were conducted during *kharif* season. The farmers were asked to choose any one variety based on their end use, the kernel was purchased and given to twenty-five farmers. Based on the physical parameters the high yield varieties were tabulated (Table 1) and it was observed that highest yield was recorded with the variety CO 7 with a yield of 2630 kg/ha followed by VRI 9 and VRI 10 as 2626 kg/ha. Farmers practiced variety Western 44 (1400 kg/ha) had the lowest yield. But they preferred this variety as the commission agent gives higher price. Sensitisation was given to farmers on table purpose variety and alternative variety that was most suited for Thiruvarur district as VRI 10 and BSR 2. These two varieties were selected for conduct of value addition training and further studies.

On recording the oil percent, it was observed that among the table purpose peanut varieties BSR 2 had lowest oil content (45%) followed by VRI 10 (46%). Ganesan *et al.,* (2019) reported oil content of 45.01% in BSR Variety. The peanut varieties VRI (Gn) 5, Co (Gn)4 and Co7 had higher oil content of 51%, 53% and 51% respectively and recommended for oil extraction. The oils extracted with these kernels was better in colour, shelf life and quantity. Shelling outturn was also ranging from 66.5% to 70%. The average 100-kernel weight was ranging from 44-60 g and found very less in BSR 2 as 44 g. Ganesan *et al.* (2019) reported parameters for BSR 2 variety as duration-105-110 days, shelling outturn of as 70.2%. 100 kernal weight as 41.0 g. Sravani *et al.* (2020) also reported that the 100 kernel weight for different varieties range from 46.23 to 56.34 g.

Proximate composition

Based on the technology wise selection, the best TNAU released varieties namely, VRI 10 (T1) and BSR 2(T2)and one farmer practice variety (Western 44) were used for preparation of Salted peanuts, peanut chikki , peanut butter, peanut chutney powder, masala peanut and their proximate nutrient content were analyzed and presented in Table 2. It was observed that moisture, carbohydrate, protein, fat, crude fibre, was matching to the standards of Food Safety Standards Authority of India (FSSAI) in all the processed products and in all treatments.

The FSSAI standards specified for peanut butter are moisture should be not more than 3% by weight, fat not

Table 1: Physical parameters of selected peanut variety.

Variety	Yield (kg/ha)	Duration days	Oil content %	Shelling outturn%	100 kernel weight (g)
VRI 9	2626	110-115	47	71	47
VRI 10	2492	90-95	46	70-72	52
BSR2	2352	100-105	45	70.2	44
VRI (Gn) 5	2384	105-110	51	75	46
Co(Gn) 4 TNAU269	1950	115-120	53	70	60
Co7	2630	100-105	51	71	52
Western 44	1400	110-115	47	66.5	45

Table 2: Proximate composition of the peanut products.

Products	Moisture (%)			Carbohydrate (%)			Protein (%)			Fat (%)			Crude fibre (%)		
	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP
Salted peanuts	5.80±	5.67±	5.78±	20.12±	20.52±	20.50±	22.32±	22.16±	22.03±	48.20±	48.20±	48.4	2.20±	2.14±	2.66±
	0.06	0.16	0.09	3.12	2.04	3.02	0.48	1.40	1.45	2.12	3.60	6±3.04	0.02	0.01	0.50
Peanutchikki	5.32±	5.27±	5.28±	55.36±	52.52±	49.42±	23.22±	23.41±	23.43±	48.96±	49.24±	48.36±	2.26±	2.74±	4.96±
	0.20	0.30	0.21	3.20	2.84	3.82	0.98	1.20	1.70	3.12	3.20	3.54	0.26	0.12	0.58
Peanut butter	2.30±	2.12±	1.98±	23.20±	24.06±	22.20±	22.60±	22.40±	21.26±	49.52±	48.98±	49.12±	2.46±	2.31±	2.89±
	0.16	0.01	0.14	1.30	1.25	3.40	1.70	2.50	2.40	2.60	3.45	3.30	0.15	0.12	094
Peanut chutney powder	5.20±	5.12±	5.28±	19.62±	19.82±	19.42±	22.86±	23.16±	23.43±	47.95±	48.24±	48.36±	4.32±	4.60±	4.96±
	0.18	0.06	0.21	1.82	1.23	3.82	1.42	1.08	1.70	3.62	3.51	3.54	0.62	0.74	0.58
Masala peanut	5.32±	5.06±	5.62±	19.40±	19.58±	19.02±	22.92±	23.09±	23.80±	47.62±	48.22±	48.60±	4.26±	4.30±	4.96±
	0.20	0.81	0.21	1.20	2.92	3.02	3.01	2.10	1.01	3.20	3.15	3.04	1.12	0.92	0.58

T_1- VRI 10; T_2- BSR 2; FP- Western 44.

Values represent average of three replicates±standard deviations.

Table 3: Free fatty acid and peroxide value of the peanut products.

Products	Free fatty acid content (%)			Peroxide value (meq/kg)		
	T_1	T_2	FP	T_1	T_2	FP
Salted peanuts	0.09±0.006	0.12±0.006	0.092±0.02	1.12±0.12	1.13±0.04	1.05±0.02
Peanut chikki	0.10±0.002	0.10±0.002	0.078±0.02	1.10±0.20	1.05±0.08	1.02±0.02
Peanut butter	0.11±0.006	0.11±0.005	0.065±0.04	1.03±0.30	1.06±0.25	1.20±1.40
Peanut chutney powder	0.12±0.007	0.12±0.002	0.087±0.02	1.02±0.02	1.02±0.23	1.02±0.02
Masala peanut	006±0.001	0.09±0.006	0.09±0.01	1.02±0.01	1.08±0.09	1.02±0.02

T_1- VRI 10; T_2- BSR 2; FP- Western 44 and G7 varieties.

Values represent average of three replicates±standard deviations.

Table 4: Organoleptic parameters of selected varieties.

Products	Colour			Flavour			Taste			Texture			Over all acceptability		
	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FP
Salted peanuts	8.95± 0.01	8.84± 0.09	8.85± 0.04	8.63± 0.81	8.42± 0.21	8.32± 0.08	8.54± 0.24	8.15± 0.11	8.05± 0.07	8.95± 0.07	8.74± 0.01	8.02± 0.03	8.74± 0.07	8.32± 0.12	8.14± 0.06
Peanutchikki	8.24± 0.61	8.01± 0.01	8.00± 0.38	8.03± 0.75	8.02± 0.92	8.02± 0.46	8.75± 0.41	8.62± 0.53	8.21± 0.71	8.88± 0.13	8.70± 0.08	8.42± 0.01	8.52± 0.27	8.20± 0.21	8.12± 0.07
Peanut butter	8.01± 0.94	8.85± 0.27	7.13± 0.11	8.01± 0.14	8.99± 0.90	7.36± 0.39	7.34± 0.47	8.02± 0.51	7.31± 0.71	8.24± 0.18	8.26± 0.35	8.56± 0.33	8.12± 0.25	8.64± 0.34	7.31± 0.84
Peanut chutney powder	7.94± 0.10	8.25± 0.28	7.01± 0.14	8.01± 0.52	8.86± 0.14	7.96± 0.02	7.10± 0.12	8.00± 0.01	7.11± 0.25	8.01± 0.01	8.31± 0.30	7.88± 0.14	7.34± 0.20	7.84± 0.11	7.01± 0.88
Masala peanut	7.84± 0.19	8.20± 0.08	8.01± 0.86	8.01± 0.72	8.86± 0.53	8.10± 0.06	8.22± 0.10	8.60± 0.08	7.74± 0.17	7.83± 0.12	8.24± 0.76	8.12± 0.24	8.14± 0.32	8.44± 0.75	8.02± 0.011

T_1- VRI 10; T_2- BSR 2; FP- Western 44.
Values represent average of three replicates ± standard deviations.

less than 40% by weight, protein not less than 25%. In roasted nuts the moisture should be less than 7% in all the treatments.

Among the value added products, salted peanut had higher (5.80±0.06- T_1) moisture content and it was lower in the peanut butter (1.98±0.14-FP). The carbohydrate content was found highest in chikki the increase in value is due to addition of jaggery. The carbohydrate in peanut butter was (22.2 to 24.0%) Sithole *et al.* (2022) correlated that sweetness trait and roasted flavour is due to presence of carbohydrate content. The protein analysis showed that, peanut chikki is a good source of protein (23.43±1.70- FP) followed by the masala peanut, peanut chutney powder and peanut butter. Peanut butter protein content ranged from 21.2 to 22.6% Similar results were reported by Saheedat *et al.* (2018) and they stated that protein content of peanut butter was 25.50±0.44%. The crude fat content of peanut butter was also recorded in all the samples and peanut butter (VRI 10) had higher fat content (49.52±2.60). Gao *et al.* (2022) reported peanut butter had a high fat content of 42.20±0.10% Bansal and Kochhar (2013) developed peanut based value added products products were found to be highly nutritious as gives protein content of 14.53% soup, 22.75% Pancake, Kheer provides 18.10%, Vadiya, 31.00% and Papad provides 20.58 g of protein.

Keeping quality of peanut products

The free fatty acid and peroxide value was estimated and presented in the Table 3. Free fatty acid content of oil measures the extent of deterioration that has occurred by action of heat and lipase enzyme. All the developed product showed minimum amount of free fatty acid content ranged between 0.06 and 0.11%. Peroxide values of all peanut samples were under safe limits upto 60 days of storage period but then the samples worsened and exhibited significant rancidity. The shelflife period was determined based on peroxide contents greater than 10 meq/kg was considered undesirable.

Sensory evaluation of peanut products

The sensory evaluation and consumer acceptance is a desirable criterion for a product before launching in the market. The sensory properties of the all the products were desirable in all the sensory attributes the values are presented in Table 4. The same ingredients and amounts were used in the formulation of the products except for change in the variety. The results revealed that the VRI 10 nuts was bold and bigger in size and best suited for the salted peanut, peanut candy. BSR 2 variety is best suited for the preparation of peanut butter, peanut chutney powder and masala peanut in all the sensory attributes. Among the selected variety the butter prepared from kernels of BSR 2 variety yielded better firmness and spread ability. For peanut butter, flavour is one of the most important quality attribute with strong influence on consumer acceptance. Though all the varieties was roasted to the same final colour and temperature, some appreciable difference in their

Table 5: Economic parameters of peanut products.

Products	Keeping quality (days)			Gross cost (Rs/Kg)			Net return (Rs/Kg)			BCR		
	T_1	T_2	FP	T_1	T_2	FP	T_1	T_2	FPP	T_1	T_2	FP
Salted peanuts	90	100	97	90	90	90	110	120	110	1.2	1.3	1.2
Peanut chikki	90	100	97	100	100	100	115	120	105	1.15	1.2	1.05
Peanut butter	55	60	50	100	100	100	225	280	250	2.25	2.80	2.5
Peanut chutney powder	60	75	68	110	110	110	140	140	140	1.27	1.27	1.27
Masala peanut	14	16	15	130	130	130	275	300	280	2.11	2.30	2.15

T_1- VRI 10; T_2- BSR 2; FP- Western 44.

flavour was observed and the such result were also reported by Sithole *et al.* (2022). For flavour, 60% of the participants liked the products prepared with BSR 2 variety and only 40% of people liked products prepared with VRI 10 variety. But the sensory scores revealed that all the products irrespective of variety scored above 7in all attributes which was the acceptable level and coinciding with the like very much sensory score. Similar results were also observed by Kamalasundari, (2022) for the products prepared with tempeh. The acceptable percentage of peanut flour in different valued added products was reported by the Bansal and Kochhar (2013) gave overall acceptability score for peanut sou p, pancake, kheer, vadiya, papad as 7.2, 8.14, 8.51, 8.12 and 8.4 respectively.

Harvesting care, economic parameters of peanut products and costing calculation

Training and demonstration were given to 369 peanut growing farmers. In addition, economics parameters net return and benefit-cost ratio (BCR) of the peanut products were calculated and explained to the farmers (Table 5). Keeping quality was lowest for masala peanuts as it is deep fried in oil followed by peanut butter. The peanut chikki,salted nuts and chutney powder had good shelf life. Benefit cost ratio was found highest for peanut butter 2.25 to 2.5 and masala peanuts 2.11 to 2.30.

Freshly harvested peanuts pods are directly sold to commission agents. But without any processing farmer fetched an income between Rs. 50,000 to Rs. 56000 and Rs. 20000 to Rs. 25000 per acre. In this context, the farmer gets profit of about Rs. 29400 to Rs. 31000 on an average. But if the farmer processed the ground nut for primary processing and sold the profit margin will be higher. The peanut varieties with oil content of less than 50% was suggested for preparation of salted peanuts, peanut chikkis, peanut butter, peanut chutney powder, masala peanut.

The cost economics as told by the farmer was when one quintal of fresh peanut was sold to the market with a value of Rs. 3800/qt. But if it is dried for three days it can be sold for Rs. 7000/qt. The decorticated kernel was sold at Rs.100-110/kg. As on decortication only 70 kg of peanut kernel was obtained from 100 kg peanut pods. The processed kernel when used for extraction of oil gave 43-45 litre of crude peanut oil and 53-55 kg of peanut cake. The value of crude peanut oil was 270/kg and that for 45 kg oil it was Rs. 12,150. The by-product, peanut cake was priced at Rs 45/kg and for 55 kg it was Rs. 2475. The total cost involved when peanut kernel processed to peanut crude oil and cake was Rs. 14625/q. Thus, the value addition realized in manufacturing per litre of peanut oil is Rs. 30/ litre and Rs. 3000/qt after meeting all the expenses.

The total manufacturing cost was calculated as Cost= Raw Material Cost + Processing Cost 20%+ other expenses. Total production cost calculated for each product as for peanut chikki was Rs. 190/kg peanut bars and sale cost were Rs.300/kg chikki.

CONCLUSION

In view of the increasing demand of peanut products by producers, processors and consumers, the importance of postharvest and processing technology is utmost important. The assured market is lacking for the farmers. For traders assured supply of quality kernels with same variety and oil content and raw materials is difficult. As a result, the product outcome is varied in each processing. There is need to focus on availability of improved kernelsand suitability of each kernel for each product, promoting home-made products for direct human consumption, good quality peanut oil edible peanut and confectionery nuts as well as enhancement of sub-products in the rural areas. There is also need to give focus on post-harvest management techniques such as storage and conservation of products, quality control, particularly of aflatoxins, socio-economic evaluation of recommended technologies or those in practice, technology transfer etc. Promotion of peanut value chain among farmers will be viable option in in improving livelihood of peanut growing farmers. Hence, peanut played an important role in nutritional security to the resource poor farmers. To conclude oil can be extracted from varieites which has moret han 50% oil content and value addition of products can be done with varieties having less than 50% oil content.

Conflict of Interest

All authors declare that they have no conflict of interest.

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