

INTRODUCTION OF HIGH YIELDING PROTEIN RICH PULSE CROP TO THE SEMI ARID TRACTS OF INDIAN SUB-CONTINENT



Principle Investigator:
Dr. R.Nandini,
Breeder and Schem Head, AICRP
(Minor millets)
ZARS,VC Farm, Mandya,
Co-workers:
1.Dr.Nagaraju.N
2.Dr.Shamshad Begum
3.Dr.Shwetha B.V



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Kirkhouse
Trust Supporting research and education
in the biological sciences

**2013 : Introduced 6 genotypes from NRCG ,
Junagadh, 2013 through NBPGR, NEW
DELHI**

2014: Evaluated 6 genotypes, Poor adaptation

2014-15: Seed multiplication of genotypes

MAJOR CONSTRAINTS

1. Adaptability
2. Poor seed set



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



EMS Induced mutations using SB-42



mutated

Non mutated



Plate 1: Field view of Bambara groundnut in M₄ generation



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Protein and methionine estimation of selected mutants

GENOTYPES	Protein %	Methionine (mg/100gm)
control	17.45	1.73
S 80	25.94	3.56
S 105(CGK-SB-42)	26.43	3.40
S -35	18.46	3.80
S -7	17.75	2.75
S-14	17.35	3.10
S-9	17.25	2.80
S-165	25.18	2.95
S-1	21.96	2.45

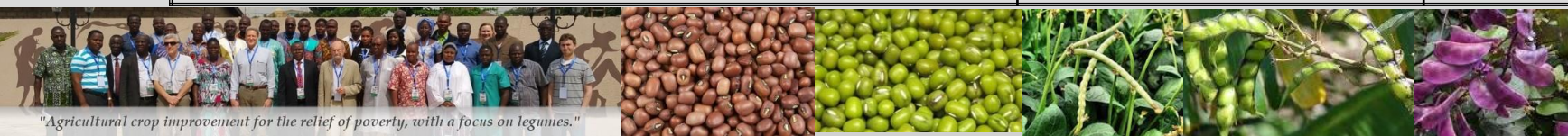


"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Nutritional composition of Bambara groundnut in comparison to other pulses :

Crop	Protein (%)	Methionine (mg/100 gm)
Bambara groundnut (<i>Vigna Subterranea</i>)	11.59-25.50	0.73-2.70
S-80	25.94	3.56
S-105(CGK-SB-42)	26.43	3.40
Cowpea (<i>Vigna unguiculata</i>)	24.1	1.84
Green gram (<i>Vigna radiata</i>)	18-24	1.80



Mineral composition of Bambara groundnut

S.N.	Minerals	Estimated quantity (mg/100g)	Reference quantity of Cow pea (mg/100g)*
1.	Ca	260	182.01
2.	P	150.73	510.00
3.	K	1723.25	768.05
4.	Mn	1.4	14.27
5.	Na	75.25	78.15
6.	Fe	3.6	5.66
7.	Cu	0.7	0.60
8.	Zn	2.2	5.66
9.	Na/K ratio	0.04	0.10
10	Ca/P ratio	1.72	0.35



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Kirkhouse Trust

Supporting research and education in the biological sciences

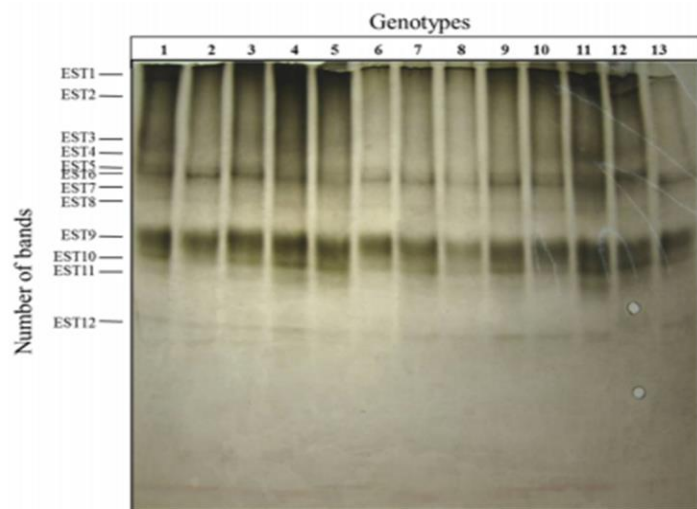


Plate 04: Esterase isozyme profile of 13 Bambara groundnut genotypes obtained by Native-PAGE: Lane 1 indicates non mutated sample of SB-42 (Control) & lane 2-13 indicates samples of mutant lines i.e. Lane 2 - F. 10 (2), Lane 3 - F. 3-1 (1), Lane 4 - F. 6-8 (4), Lane 5 - F. 55-1 (4), Lane 6 - F. 7 (2), Lane 7 - F. 3 (3), Lane 8 - F. 8(2), Lane 9 - F. 12 (1), Lane 10 - F. 20 (2), Lane 11 - F. 7 (5), Lane 12 - F. 55-1 (3), Lane 13 - F. 8 (4).

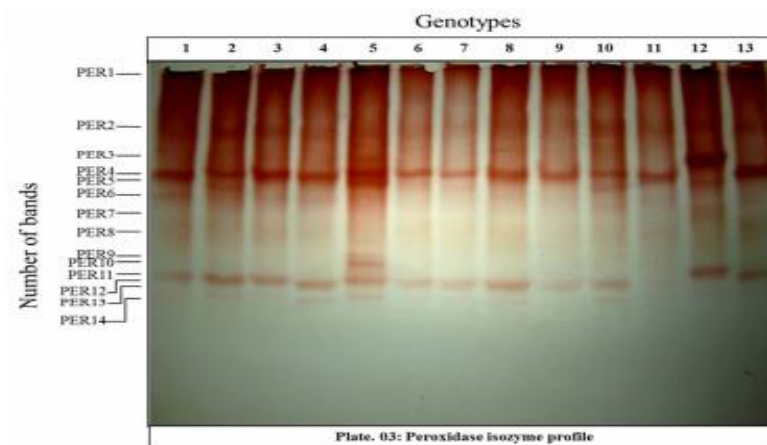


Plate 05: Peroxidase isozyme profile of 13 Bambara groundnut genotypes obtained by Native-PAGE: Lane 1 indicates non mutated sample of SB-42 (Control) & lane 2-13 indicates samples of mutant lines i.e. Lane 2 - F. 10 (2), Lane 3 - F. 3-1 (1), Lane 4 - F. 6-8 (4), Lane 5 - F. 55-1 (4), Lane 6 - F. 7 (2), Lane 7 - F. 3 (3), Lane 8 - F. 8(2), Lane 9 - F. 12 (1), Lane 10 - F. 20 (2), Lane 11 - F. 7 (5), Lane 12 - F. 55-1 (3), Lane 13 - F. 8 (4).

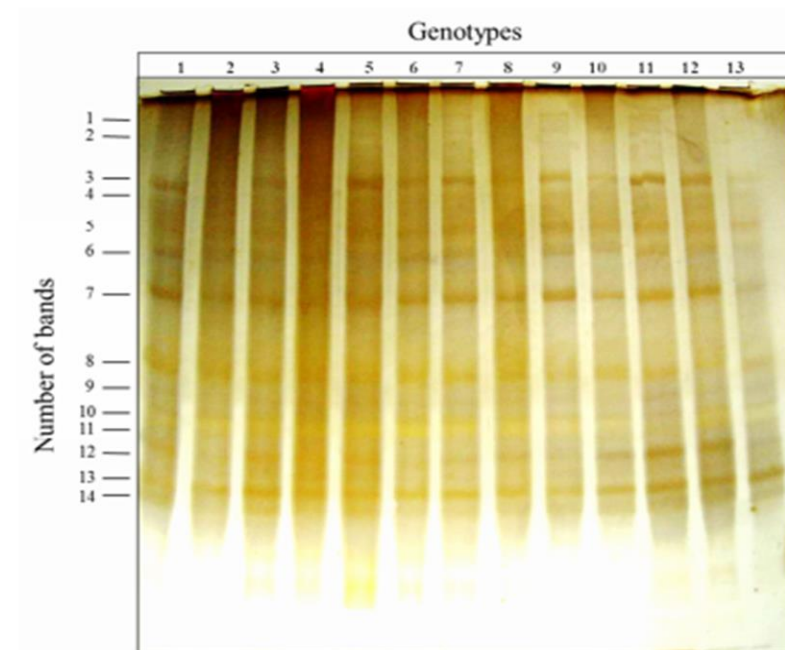
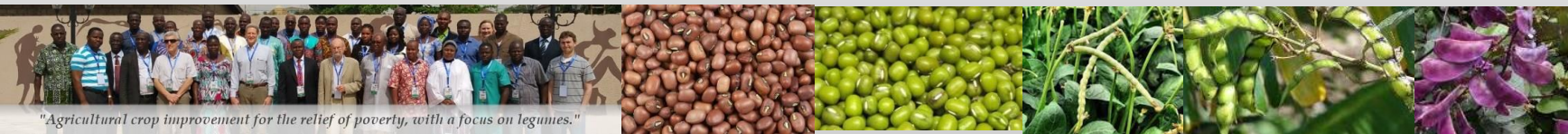


Plate 03: Protein profile of 13 Bambara groundnut genotypes obtained by SDS-PAGE: Lane 1 indicates non mutated sample of SB-42 (Control) & lane 2-13 indicates samples of mutant lines i.e. Lane 2 - F. 10 (2), Lane 3 - F. 3-1 (1), Lane 4 - F. 6-8 (4), Lane 5 - F. 55-1 (4), Lane 6 - F. 7 (2), Lane 7 - F. 3 (3), Lane 8 - F. 8(2), Lane 9 - F. 12 (1), Lane 10 - F. 20 (2), Lane 11 - F. 7 (5), Lane 12 - F. 55-1 (3), Lane 13 - F. 8 (4).



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

Comparison of Ancillary characters of selected mutant (High protein and high methionine) CGK-SB-42 and check SB-42

Sl. No.	Character	CGK-SB-42	SB-42(Check)
1.	Days to 50% flowering	50.71	54.28
2.	Plant Height (cm)	27.57	15.57
3.	Plant Spread (cm)	59.74	25.71
4.	No.of Branches	40.28	22.28
5	No.of Pods/Plant	20.14	7.71



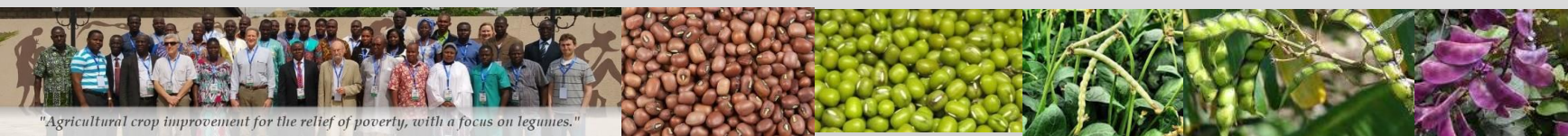
"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



CGK-SB-42

Proposed for Farm Trials, in the pipeline to be released as variety at UAS,GKVK,Bengaluru.

- **120 days duration**
- **High Yielding**
- **Suitable for *Kharif* & Summer**
- **High Pod Yield**



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Kirkhouse Trust Supporting research and education in the biological sciences

"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

Experiments on Nodulation



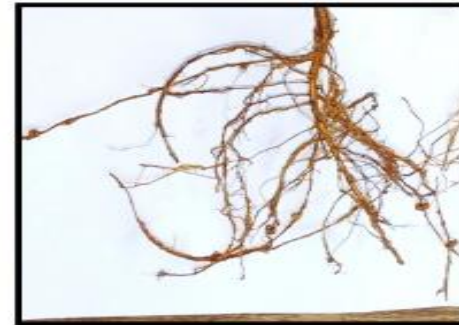
Single seeded pod in SB-42 variety

Double seeded mutant

Plate 5: SB-42 pure variety and the mutant having double seeded pods at 200 Gy+0.3 per cent EMS.



Plate 6. Mutation observed for seed mottling at 200 Gy+0.3 per cent EMS.



SB-42 pure variety



High nodulating mutant of SB-42 variety

Plate 7: SB-42 parent and high nodulating mutant in Bambara groundnut



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



**Kirkhouse
Trust**

Supporting research and education
in the biological sciences

Molecular screening for MYMV



Plate 1: Yellow mosaic virus disease susceptible plant



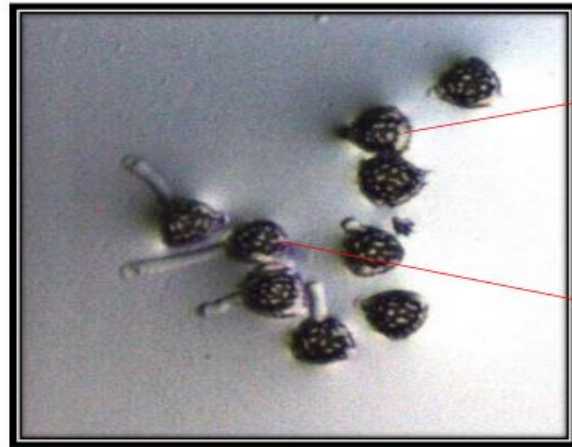
Plate 2: Yellow mosaic virus disease resistant plant



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



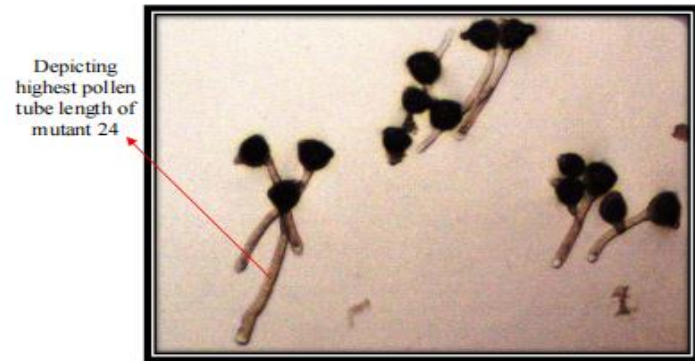
STUDIES ON REPRODUCTIVE BIOLOGY



Diameter of ungerminated pollen grain

Diameter of germinated pollen grain

Plate 7. Pollen germination of Bambara groundnut pollen grain in pollen tube growth media



Depicting highest pollen tube length of mutant 24

Plate 8. Pollen tube growth of Bambara groundnut pollen grain in pollen tube growth media

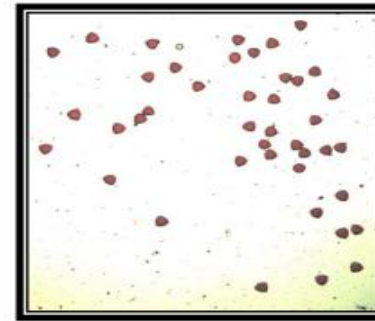


Plate 9. Maximum Pollen viability of SB-42 at 1 a.m.

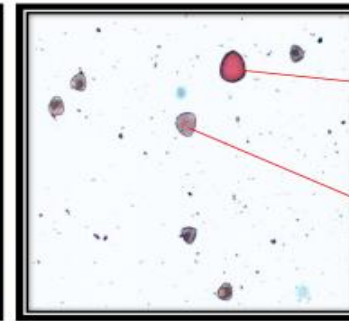
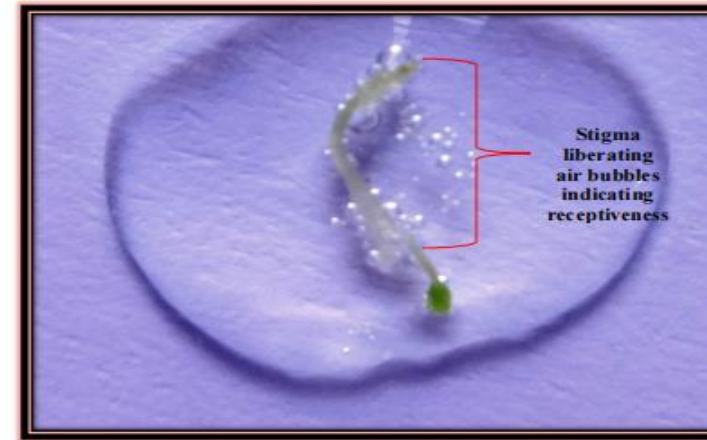


Plate 10. Minimum Pollen viability of SB-42 at 1 p.m.

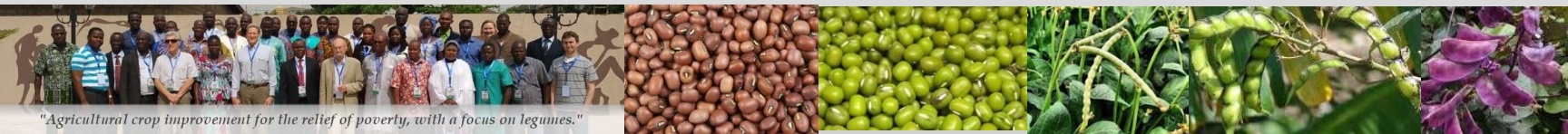
Viable pollen

Non-viable pollen



Stigma liberating air bubbles indicating receptiveness

Plate 11. Peroxidase activity on *Vigna subterranea* stigma indicating receptiveness by liberating air bubbles



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

*Molecular , Nutritional and Environmental Evaluation of Bambara groundnut
Vigna subterranea(L.Verdc.) for food production in the Indian Sub-continent”*



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."





"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



**Kirkhouse
Trust**

Supporting research and education
in the biological sciences

Major Constraint

- Farmers acceptance?
- Marketability?
- How to use ?
- Seed Processing?



Training Programmes to farm women development of value added products of bambara groundnut



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



**Kirkhouse
Trust**

Supporting research and education
in the biological sciences

Results of station trials and multi location trials



Developed :

Standardization of management practices

Developed economically important mutants-High yield,protein and YMV resistance(using heterologous probes

Sequencing of gene for YMV resistance

-Field trials of the crop along with Participatory varietal selection

Estimating the potential Bambara groundnut as inter crop and sole crop

Development of value added products

Popularization of the crop and its value added bi-products.



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Kirkhouse Trust

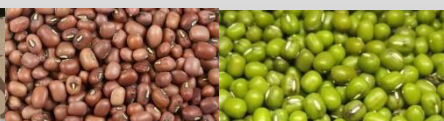
Supporting research and education in the biological sciences

Pooled data of Pod yield in Station trial and MLT (q/ha)

Sl. No.	Genotype	Station trial			MLT			Mean	% increase over Check SB 42
		<i>Kharif</i> 2017	<i>Kharif</i> 2018	<i>Kharif</i> 2019	GKVK, Bengaluru	Hadonahalli KVK	Balajigapade		
1	CGK-SB42	17.03	13.94	17.25	17.25	24.3	7.905	15.88	353.71
3	SB 42	3.086	4.45	4.17	4.17	(no germination)	1.962	3.50	
Mean		9.86	9.51	10.34	10.34	22.55	4.933		
F value		**	**	**	**	**	**		
SEm±		0.592	0.469	0.547	0.469	-	0.246		
CD@5%		1.844	1.461	1.703	1.461	-	0.766		
CV%		15.844	13.041	13.989	13.041	-	12.701		



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

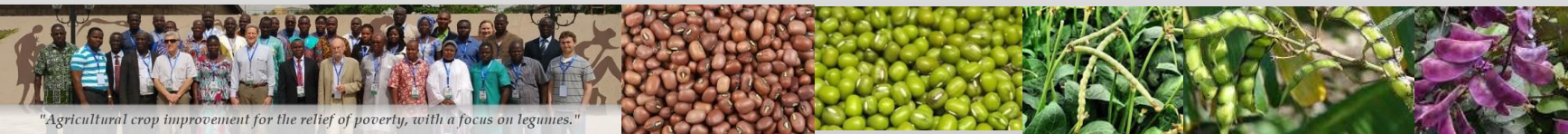


Kirkhouse Trust

Supporting research and education in the biological sciences

Projects handled on Bambara groundnut

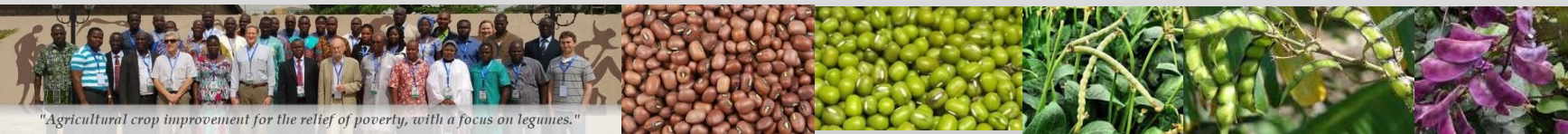
1. Directorate of Research: UAS,GKVK,Bengaluru: Development of High yielding protein rich Bamabara groundnut.
2. PPV & FRA, Govt of India :Development of DUS Guidelines for Bambara groundnut



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

Plant Descriptors of Bambara Groundnut

1. Peduncle length(mm)
2. Plant height (cm)
3. Plant spread(cm)
4. Number of leaves
5. Terminal leaflet length(mm)
6. Terminal leaflet width(mm)
7. Petiole length(mm)
8. Photoperiodic reaction type
9. Number of days for first flowering
10. Number of flowers per peduncle
11. Days to 50% flowering
12. Dark pigmentation on wings and banner
13. Pod length [mm]
14. Pod width [mm]
15. Pod shape
16. Pod color
17. Pods per plant
18. Pod texture
19. Seed shape
20. Seed color/ pattern
21. Seeds per pod
22. Seed yield per plant (g)
23. Seed length(mm)
24. Seed width(mm)
25. Shelling percentage (%)
26. Test weight (g)
27. Protein %
28. Carbohydrate %..



Genotypes introduced:

Sl no.	Genotype	Sl no.	Genotype	Sl no.	Genotype	Sl no.	Genotype
1	TVSu 1887	26	TVSu 1614	51	TVSu 633	76	TVSu 1829
2	TVSu 1321	27	TVSu 62	52	TVSu 217	77	TVSu 1648
3	TVSu 1631	28	TVSu 6	53	TVSu 303	78	TVSu 1123
4	TVSu 1737	29	TVSu 1448	54	TVSu 565	79	TVSu 138
5	TVSu 536	30	TVSu 541	55	TVSu 106	80	TVSu 367
6	TVSu 1394	31	TVSu 1388	56	TVSu 1940	81	TVSu 1431
7	TVSu 1379	32	TVSu 270	57	TVSu 1069	82	TVSu 989
8	TVSu 1034	33	TVSu 455	58	TVSu 878	83	TVSu 1459
9	TVSu 328	34	TVSu 11	59	TVSu 158	84	TVSu 1693
10	TVSu 574	35	TVSu 1068	60	TVSu 458	85	TVSu 1108
11	TVSu 1260	36	TVSu 132	61	TVSu 5	86	TVSu 1403
12	TVSu 235	37	TVSu 591	62	TVSu 698	87	TVSu 1668
13	TVSu 1833	38	TVSu 1633	63	TVSu 1606	88	TVSu 1051
14	TVSu 545	39	TVSu 885	64	TVSu 425	89	TVSu 975
15	TVSu 926	40	TVSu 627	65	TVSu 275	90	TVSu 334
16	TVSu 592	41	TVSu 287	66	TVSu 884		
17	TVSu 1364	42	TVSu 1408	67	TVSu 1272		
18	TVSu 330	43	TVSu 329	68	TVSu 1972		
19	TVSu 740	44	TVSu 598	69	TVSu 1641		
20	TVSu 44	45	TVSu 975	70	TVSu 1038		
21	TVSu 283	46	TVSu 1253	71	TVSu 1049		
22	TVSu 723	47	TVSu 1451	72	TVSu 1662		
23	TVSu 1620	48	TVSu 640	73	TVSu 611		
24	TVSu 445	49	TVSu 505	74	TVSu 442		
25	TVSu 1721	50	TVSu 1684	75	TVSu 702		



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



**Kirkhouse
Trust**

Supporting research and education
in the biological sciences

“Work completed”

**Official procurement of
germplasm accessions**

August, 2022

**Introduced germplasm accessions from Nigeria are monitored
for plant quarantine purpose in polyhouse**

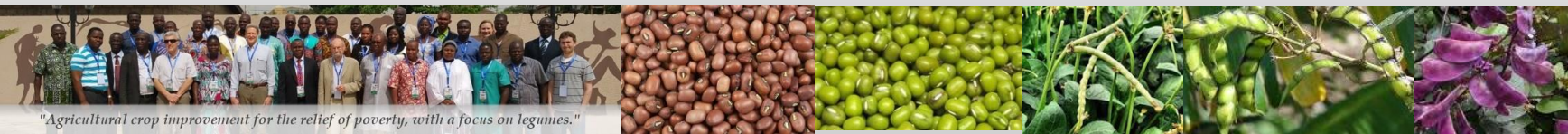
Kharif, 2022

**Remaining seeds of germplasm accessions which was not
taken up in the first round of quarantine was taken up under
polyhouse condition for multiplication Seeds harvested from
polyhouse during Kharif 2022 used for mass multiplication
under field condition**

Summer, 2023

1stEvaluation of germplasm

Kharif, 2023



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



Visit by NBPGR



TVSu-740

⋮

General view of experimental area



Genotypes having more number of branches



TVSu-6



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



To be continued.....

1. Biochemical estimation

2. Disease screening using markers continued

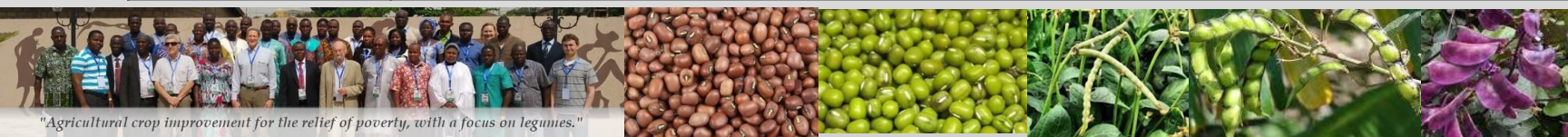


Bambara groundnut CGK-SB-42



Details of student Research on Bambara groundnut

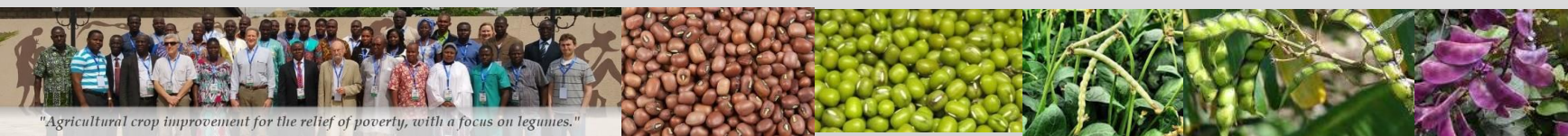
Name	Title of Research
Chitti bhaskar	Genetic improvement of bambara groundnut (<i>Vigna subterranea</i> (L.) verdc) through mutation breeding
CHANDANA, B. S.	Studies on biochemical parameters in bambara groundnut [<i>Vigna subterranea</i> (L.) verdc.]
PRANESH	Variability studies in m3 generation and Screening for yellow mosaic virus disease Resistance in isolated mutants of Bambara groundnut [<i>Vigna subterranea</i> (L.) verdc.]
SMITA SUBHASH VEERAGHANTI	Studies on Genetic Variability in M3 generation of Bambara groundnut (<i>Vigna subterranea</i> (L.) Verdc.) treated with gamma rays.
UMESHA NAIK	Correlation and path coefficient analysis between seed yield and its component characters in m4 and m5 generations of Bambara groundnut (<i>Vigna subterranea</i> (L.) Verdc.)
KHAJABANDEN AWAJ	Evaluation of bambara groundnut (<i>Vigna subterranea</i> (L.) verdc.) mutants for yield, protein and related characters.
PUSHPALATHA	Effect of induced mutation on economic traits and nodulation in bambara groundnut (<i>Vigna subterranea</i> (L.) Verdc).
KAILASH CHANDRA Vijayakumara	Studies on reproductive biology and nutritional analysis in bambara groundnut (<i>Vigna subterranea</i> (L.) Verdc.) Gamma irradiated variability studies in bambara groundnut (<i>Vigna subterranea</i> (L.)Verdc.)



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

List of publications on Bambara groundnut studies

1. SMITA, NANDINI, R., 2014, Trait Association and path analysis for yield and related traits in Bambara groundnut (*Vigna subterranea*), Trends in Biosciences, 7(10), 955-957
2. SMITA, NANDINI, R., 2014, Genetic enhancement of protein content in Bambara groundnut (*Vigna subterranea*) through induced mutagenesis, Trends in Biosciences, 7(10) 918- 920
3. CHITTI BHARATKUMAR AND NANDINI, R., 2015, Mutagenic effectiveness and efficiency of ethyl methane sulphonate in bambara groundnut (*Vigna subterranea* (L.) Verdc.), MJAS, 49(2), 253-257.
4. NANDINI, R, CHITTI BHARATH, VIJAYAKUMARI AND MUTHURAJU, 2015, Variability studies in Bambara groundnut (*Vigna Subterranea* (L.) Verdc.) due to gamma irradiation, Bioinfolet, Vol12, No.4 (A) 786-794
5. CHITTI BHARATH AND NANDINI, R, 2015 Mutagenic effectiveness and efficiency of ethyl methane Sulphonate in Bambara groundnut (*Vigna subterranea*), MJAS, 49(2) 253-257
6. CHITTI BHARATH, NANDINI, R, DHANAPAL, G.N, SHASHIDHAR, H. E., AND SAVITHRAMMA, D. L, 2015 Genetic enhancement of protein methionine content in Bambara groundnut mutation breeding, International Journal of Research in Agriculture and Forestry, Vol.2 (11), 1-11
7. PRANESH, NANDINI, R. AND RAGHAVENDRA, P., 2016, Assessment of genetic variability, heritability and genetic advance in M3 generation of Bambara groundnut (*Vigna Subterranea* (L.) Verdc.) Advance in Life Sciences. 5(9):1499-1502.
8. KAILASH CHANDRA, R. NANDINI, PRANESH AND CHITTI BHARATH KUMAR, 2017, A protein rich legume, XXXI Flower, Vegetable and fruit show, Department of Agriculture, Farm Fest 2017, Govt. of Pondicherry, 27th-29th Jan 2017, Pg 94-96
9. KAILASH CHANDRA , NANDINI, R., PRANESH, CHITTI BHARATH AND GOBU, R., 2017 Improving the nutritional security of India through a Potential Underutilized Legume Bambara Groundnut (*Vigna subterranea* (L.) Verdc), Environment and Ecology, 35(2):606-610.
10. PRANESH, NANDINI, R, KAILASH CHANDRA, RANGAIAH, S AND NAGARAJU, N., 2017, Character Association and Path Analysis of Yield and Yield components in M3 Generation of Bambara groundnut (*Vigna subterranea* (L.) Verdc.) treated with Ethyl Methane Sulphonate (EMS), Int. J. Pure App. Biosc., 5(3):306-311.
11. PRANESH, NANDINI, R, KAILESH CHANDRA AND N. NAGARAJU, 2018, Screening of Bambara Groundnut (*Vigna Subterranea*) mutant Lines for yellow mosaic virus Disease resistance using SSR markers, International Journal of Current microbiology and Applied Sciences, Vol 7 : 4 : 2872 – 2880
12. KAILASH CHANDRA, NANDINI, R., GOBU, R., PRANESH, CHITTI BHARATH KUMAR AND MUTHURAJU, R., 2019, Insight into the floral biology and ancillary characteristics of underutilized legume-Bambara groundnut (*Vigna subterranea*). Legume Research., 42:96-101



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."

INSHORT



SIKKIM UNIVERSITY
(A Central University established by an Act of Parliament of India, 2007)
Department of Horticulture | School of Life Sciences

Certificate of Best Paper

This best paper award is presented to Dr. / Mr. / Ms. R. NANDINI, Assistant Professor, UAS for SECOND outstanding best paper entitled "STUDIES ON REPRODUCTIVE BIOLOGY AND NUTRITIONAL ANALYSIS IN BAMBARA GROUNDNUT *Vigna subterranea (L.)VERDC.*" for the oral presentation category during the International Symposium on "Next Generation Approaches for Sustainable Development of Hill and Upland Horticulture" held on 5th - 7th November 2015 at Sikkim University, Gangtok, Sikkim, India.


Dr. S. MANIVANNAN
Organizing Secretary
INSHORT - 2015

Co-organized by

Department of
Horticulture



Sponsored by



THANK YOU



"Agricultural crop improvement for the relief of poverty, with a focus on legumes."



**Kirkhouse
Trust**

Supporting research and education
in the biological sciences