

Influence of land configuration on crop yield of *kharif* Groundnut (*Arachis hypogaea*) based cropping sequence under rainfed upland situation

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ABSTRACT

Aim: The aim of the study was to evaluate influence of land configuration on crop yield of *kharif* Groundnut (*Arachis hypogaea*) based cropping sequence under rainfed upland situation.

Materials and Methods: The experiment was laid out in split plot design with three replications comprising twelve treatment combination with four main plots of land configuration practices *i.e.* M1: BBF 90cm × 30cm, M2: BBF 120cm × 30cm, M3: BBF 150cm × 30cm, M4: Flatbed and three Sub plots of crop sequence *i.e.* C1: *Kharif* groundnut-toria, C2: *Kharif* groundnut-pea, C3: *Kharif* groundnut- rajmah. Treatment with the bed size BBF 150cm × 30cm recorded the maximum values of yield attributing parameters *viz.* number of branches plant⁻¹, number of pod plant⁻¹, pod yield (33.89 qha⁻¹) and stover yield (72.73 qha⁻¹) and harvest index (31.80 %) in groundnut. The flatbed recorded the lowest pod yield (29.06qha⁻¹), stover yield (67.22qha⁻¹) and harvest index (30.18%) in groundnut.

Results: Results revealed that treatment BBF 150cm × 30cm had the highest groundnut equivalent yield compared to the other treatments. The system duration and land utilization index did not differ significantly amongst land configuration methods. The BBF 150cm × 30cm recorded significantly higher production efficiency and rainwater productivity of the system. The highest cultivation cost was recorded under BBF 90cm × 30cm whereas gross return, net return, B:C ratio and economic efficiency were recorded under BBF 150cm × 30 cm.

Conclusion: It was concluded that groundnut-rajmah was best performing crop sequence in terms of system yield, production efficiency, and economic return, followed by the groundnut-pea sequence.

Keywords: BBF, Land configuration, Cropping sequence, *Kharif* groundnut, Economic efficiency.

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Introduction

Rainfed agriculture is most common in our country which accounts for 92.8 million hectares that is 65% of the net area sown. It provides 44% to the country's food grain production (Gangwar *et al.*, 2012) thus it contributes to country's economy and food security. Since, rainfed agriculture is widely followed in Assam where farmers depend entirely on rainfall for water so, planning and crop management strategies according to the rainfall pattern of the region is crucial in maintaining crop yield at reasonable level in rainfed conditions (Deka and Nath, 2000).

The raised and sunkenbed, ridge and furrow and broadbed and furrow (BBF) systems are among the land surface management techniques that show great promise for regulating surface runoff, decreasing soil erosion and enhancing infiltration. By decreasing runoff water velocity, the BBF landform management method expands the time of water penetration and minimizes sediment losses. Additionally, the furrow prevents water congestion to the crop by allowing extra water to easily drain away from the plots during times of heavy rainfall (Borde *et al.* 2022). BroadBed Furrow (BBF) method is an emerging practice of land configuration in rainfed farming system that conserves moisture in the soil during dry periods while draining water in furrows during heavy rains. (Baruah *et al.* 2021) Groundnut (*Arachis hypogaea* L) is an important food legume found in tropical and subtropical regions. It is also known as peanut, monkey nut,

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earth nut due to its underground growth. It is mostly grown on a large scale in Brazil, Argentina, Senegal, Indonesia, Nigeria, China, India and USA (Singh *et al.*, 2004). The "King of Oilseeds," groundnut, is the 2nd most produced oilseed in India and the 3rd most in the world. India is the world's greatest producer of groundnuts in terms of area and ranked 2nd in production. In Assam, the main oilseed crops that occupy the majority of the oilseed area are rape seed, mustard and sesamum. Although the groundnut is cultivated in a small area but there is a significant potential for its expansion, particularly in the bed of the Brahmaputra River ("char" areas).

In cropping sequence different crops like cereal, pulse, oilseed etc. are included. Cropping sequences is the cultivation of a series of crops on a single field at a specific time. Cropping designs with multiple crops are typically composed of elements of crop sequences with a beneficial crop and an exploitative crop with respect to plant growth and soil fertility (Castellazzi *et al.* 2008).

Materials and Methods

The field experiment was conducted at the experimental field of All India Coordinated Research Project for Dryland Agriculture, Biswanath College of Agriculture, Biswanath Chariali, Assam Agricultural University, during *kharif* and *rabi* seasons of 2023-24. The experimental site is situated at 26°43'30" N latitude and 93°08'0" E longitude having an elevation of 86.70 m above mean sea level. The climatic condition of Biswanath Chariali of Biswanath district under North Bank Plain Zone (NPBZ) of Assam as a whole is sub-tropical having hot and humid summer, dry and cool winter and high relative humidity. The total rainfall received during crop growth period (*kharif* and *rabi* season) was 678.70 mm. The number of rainy days was 44 during the crop growing period of both the seasons. The weekly averaged maximum and minimum temperature ranged from 22.99° to 36.64°C and 9.77°C to 27.10°C, respectively.

The soil of the experiment was sandy loam in texture and the initial available soil nitrogen, phosphorus and potassium were in the range 388.86 kg ha⁻¹, 16.83 kg ha⁻¹ and 164.45 kg ha⁻¹ respectively.

The experimental field was laid out into three blocks and each block was divided into four main

plots to allocate the four land configuration practices randomly, for growing *kharif* (groundnut) and *rabi* (toria, pea and rajmah) crops in sequence, following the principles of Split plot design. The layout of the experiment consisting of the broadbed furrows at 90cm, 120cm and 150cm apart with 30cm width furrow in between them were constructed manually along with the flatbeds before sowing of groundnut. The main plots were divided into three sub-plots in *rabi* season to allocate the *rabi* crops randomly following a split-plot design and *kharif* groundnut crops were analysed in RBD.

In *rabi* season, after harvest of groundnut, all the plots in each block were prepared manually, retained the broad bed furrows and sub-plots and three *rabi* crops *viz.* toria, pea and rajmah were allocated following a split-plot design. However, due to dissimilarity in biometric observations on different *rabi* crop parameters, only average value of yield attributes and yield were recorded for the *rabi* crops. The yield parameter was converted into groundnut equivalent yield after harvesting of the *rabi* crops. The parameters for cropping system are determined by following formula:

Groundnut equivalent yield (GEY) of *rabi* crops: Seed yields of toria, pea and rajmah were converted to groundnut equivalent yield by using the formula

Groundnut equivalent yield

$$Gy + C1y \times \frac{Pc1}{Pc} + C2y \times \frac{Pc2}{Pc}$$

Where,

Gy = yield of groundnut

Pc = price of groundnut

C1y = yields of *Kharif* crops

C2y = yields of *rabi* crops which are to be converted to the equivalent of main crop yield

PC1, PC2 = price of *rabi* crops

Land utilization index (%): LUI (%) = TND/100

Where, TND = total number of days field remained occupied under different crops

Production efficiency (kg ha⁻¹ day⁻¹): The production efficiency (PE) is the production of a cropping system per day in a unit area which is calculated by the formula

$$PE = \frac{GEY \text{ in kg}}{\text{Duration of the cropping system}}$$

Rain water productivity (kg ha⁻¹ mm⁻¹):

$$RWP = \frac{GEY \text{ in kg}}{\text{Total rainfall (mm) received during cropping system}}$$

Economic efficiency (Rs ha⁻¹ day⁻¹): Different cropping systems were evaluated for their economic efficiency (EE) by the formula

$$EE = \frac{\text{Net return of the cropping system}}{\text{Total duration of the cropping system}}$$

Results and Discussion

Effect of land configuration practices on kharif groundnut

Yield attributes: The yield attributes viz. branch plant⁻¹ and pod plant⁻¹ (Table 1) of kharif groundnut due to different land configuration practices differed significantly. The effect of the treatments BBF 150-30cm on branch plant⁻¹ with (8.22) was found maximum which is significantly at par with treatment BBF 120-30cm with (8.11) and BBF 90-30cm with (7.11) and flat bed with (6.63) was found minimum. In respect to number of pod plant⁻¹ maximum (42.45) and minimum (35.44) was recorded in BBF 150-30 cm and flatbed respectively and former one is statistically at par with BBF 120-30cm with (40.57).

Table 1: Effect of land configuration practices on yield attributes of kharif groundnut

Treatment	Branch plant ⁻¹	Pod plant ⁻¹	Seed pod ⁻¹	Seed index(g)
Land configuration practices				
M1:BBF90 cm x 30cm	7.11	35.82	1.85	43.23
M2:BBF120 cm x 30cm	8.11	40.57	2.30	44.07
M3:BBF150 cm x 30cm	8.22	42.45	2.93	45.04
M4: Flat bed	6.63	35.44	1.96	43.13
SEd±	0.48	1.33	0.42	0.98
CD(P=0.05)	1.19	3.32	NS	NS

The number of branch plant⁻¹ and number of pod plant⁻¹ were significantly influenced by different land configuration practices. BBF 150-30cm recorded superiority in all parameters while, flatbed recorded the worst. This best result obtained might be due to fact of loose soil surface which helped better root growth and development thereby giving room for efficient accessibility of water and nutrients. These findings align closely with Kamble *et al.* (2016) who reported that the broad bed furrow created a loose soil structure with sufficient moisture retention, promoting favourable conditions for peg penetration and pod development. Higher pod plant⁻¹ in the furrow methods of planting (Chowdary *et al.*, 2022) is because excess rainfall is properly directed through furrows.

Pod and Stover Yield: Data on pod yield and stover yield of kharif groundnut as influenced by different land configuration (Table 2). Results revealed that pod yield under the treatment BBF 150-30cm (33.89 qha⁻¹) was produced significantly higher pod yield which is followed by BBF 120-30cm (32.72 qha⁻¹) and BBF 90-30cm (30.17 qha⁻¹). While the lowest pod yield (29.06 qha⁻¹) was recorded under the flat bed method of sowing. In respect to stover yield, BBF 150-30cm resulted in higher value (72.73 qha⁻¹) which is at par with BBF 120-30cm (70.94 qha⁻¹) and BBF 90-30cm (69.17 qha⁻¹) and flat bed recorded the least stover yield (67.22 qha⁻¹).

Table 2: Effect of land configuration practices on pod and stover yield of kharif groundnut

Treatment	Pod yield (qha ⁻¹)	Stover Yield (qha ⁻¹)	Harvest Index (%)
Land configuration practices			
M1:BBF 90 cm x 30cm	30.17	69.17	30.37
M2:BBF 120 cm x 30cm	32.72	70.94	31.56
M3:BBF 150 cm x 30cm	33.89	72.73	31.78
M4:Flatbed	29.06	67.22	30.18
SEd±	0.29	0.74	0.37
CD(P=0.05)	0.72	1.85	0.93

BBF150-30cm recorded the highest pod yield and stover yield which were significantly higher over all the treatments. The increase of the pod yield as well as stover yield due to loose, well-aerated seedbed found in BBF helped peg penetration and pod growth since groundnut pods grow underground, ultimately increased yield was reported by Sathiya *et al.* (2020). The broad bed furrow provided a loose soil mass with adequate soil moisture. Positive correlation existed between water use efficiency and pod yield (Bharade *et al.* 2019).

Effect of land configuration practices on Toria

Yield attributes and yields: The number of branch plant⁻¹, number of siliqua plant⁻¹, number of seed siliqua⁻¹, test weight, seed yield, stover yield and harvest index (4.17, 149.40, 17.47, 3.00g, 9.50qha⁻¹, 21.60qha⁻¹ and 30.55%, respectively) of toria were recorded highest in T7(BBF150-30cm, GN-Toria) which was followed by T4 (BBF120-30cm, GN-Toria). While, T10 (BBF Flat bed, GN-Toria) maintain the lowest number of branch plant⁻¹, number of siliqua plant⁻¹, number of seed

Table 3: Yield attributes of different *rabi* crops in crop sequences

Treatment combination	Seed/pod yield(qha ⁻¹)	Stover yield (qha ⁻¹)	Harvest Index (%)
T1:BBF90-30cm,GN-Toria	7.67	18.53	29.26
T2:BBF90-30cm,GN-Pea	8.67	24.71	25.97
T3:BBF90-30cm,GN-Rajmah	12.53	20.81	37.59
T4:BBF120-30cm,GN-Toria	9.17	21.07	30.32
T5:BBF120-30cm,GN-Pea	9.83	27.71	26.19
T6:BBF120-30cm,GN-Rajmah	13.17	21.78	37.67
T7:BBF150-30cm,GN-Toria	9.50	21.60	30.55
T8:BBF150-30cm,GN-Pea	10.17	28.47	26.32
T9:BBF150-30cm,GN-Rajmah	14.17	23.39	37.72
T10:BBFFlatbed,GN-Toria	6.33	16.70	27.50
T11:BBFFlatbed,GN-Pea	7.50	23.38	24.29
T12:BBFFlatbed,GN-Rajmah	10.50	17.98	36.86

Table 4: Seed/podyield,Stover yield and harvest index of different *rabi* crops in crop sequences

Treatment combination	Seed/pod yield(qha ⁻¹)	Stover yield (qha ⁻¹)	Harvest Index (%)
T1:BBF90-30cm,GN-Toria	7.67	18.53	29.26
T2:BBF90-30cm,GN-Pea	8.67	24.71	25.97
T3:BBF90-30cm,GN-Rajmah	12.53	20.81	37.59
T4:BBF120-30cm,GN-Toria	9.17	21.07	30.32
T5:BBF120-30cm,GN-Pea	9.83	27.71	26.19
T6:BBF120-30cm,GN-Rajmah	13.17	21.78	37.67
T7:BBF150-30cm,GN-Toria	9.50	21.60	30.55
T8:BBF150-30cm,GN-Pea	10.17	28.47	26.32
T9:BBF150-30cm,GN-Rajmah	14.17	23.39	37.72
T10:BBFFlatbed,GN-Toria	6.33	16.70	27.50
T11:BBFFlatbed,GN-Pea	7.50	23.38	24.29
T12:BBFFlatbed,GN-Rajmah	10.50	17.98	36.86

Table 5: Effect of land configuration practices and crop sequences on Groundnut equivalent yield of *rabi* crops and Groundnut equivalent yield of the cropping system

Treatment	Groundnut equivalent yield of <i>rabi</i> crops (q ha ⁻¹)	Groundnut equivalent yield of the system (q ha ⁻¹)
Land configuration practices		
M1:BBF90 cm x 30cm	10.52	40.69
M2:BBF120 cm x 30cm	11.61	44.34
M3:BBF150 cm x 30cm	12.25	46.13
M4:Flatbed	8.89	37.95
SEd±	0.48	0.45
CD(P=0.05)	1.20	1.13
Crop sequences		
C1: <i>kharij</i> Groundnut-toria	5.95	37.50
C2: <i>kharij</i> Groundnut-pea	10.70	42.08
C3: <i>kharij</i> Groundnut-rajmah	15.80	47.26
SEd±	0.45	0.56
CD(P=0.05)	0.97	1.20

siliqua⁻¹, test weight, seed yield, stover yield, biological yield and harvest index (3.35,107.33,15.80,2.88g,6.33qha⁻¹, 16.70q ha⁻¹and 27.50%,respectively) as shown (Table 3 and 4).

Effect of land configuration practices on Pea Yield attributes and yields: The highest number of branch plant⁻¹, number of pod plant⁻¹, number of seed pod⁻¹, seed index, pod yield, stover yield and harvest index (3.04,7.53,6.47, 33.37g,10.17

qha⁻¹, 28.47qha⁻¹ and 26.32%, respectively) of pea were found in T8(BBF 150-30cm, GN-Pea) which was followed by T5(BBF 120-30cm, GN- Pea). While, the lowest number of branch plant⁻¹, number of pod plant⁻¹, number of seed pod⁻¹, seed index, pod yield, stover yield and harvest index (2.57, 5.73, 5.13,31.25g,7.50qha⁻¹,23.38qha⁻¹ and 24.29%, respectively) were found in T11(BBF Flat bed, GN-Pea) as shown (Table 3 and 4).

Effect of land configuration practices on Rajmah

Yield attributes and yields: The maximum number of branch plant⁻¹(4.09), number of pod plant⁻¹(6.28), number of seed pod⁻¹(4.07), seed index (44.95g), pod yield (14.17 qha⁻¹), stover yield (23.39 qha⁻¹) and harvest index (37.72%) of rajmah were found in T9(BBF 150-30cm, GN-Rajmah) which was followed by T6(BBF 120-30cm, GN-Rajmah) and the minimum number of branch plant⁻¹(3.07), number of pod plant⁻¹(4.77), number of seed pod⁻¹(3.13), seed index (43.14g), pod yield (10.50 qha⁻¹), stover yield (17.98 qha⁻¹) and harvest index (36.86%) of rajmah were found in T12(BBF Flat bed, GN-Rajmah) as shown (Table 3 and 4).

Performance of toria, pea and rajmah: The data recorded on *rabi* crops viz. toria, pea and rajmah revealed that the yield attributes as well as the yield of different *rabi* crops were comparatively higher in all the BBF. The BBF with 150-30cm produced best followed by BBF 120-30cm and BBF90 30cm. Here too flatbed recorded the lowest values. The higher residual soil moisture content might help the *rabi* season crops to show better performance in BBF than flat bed. The BBF improved soil moisture retention and nutrient availability by directing runoff water into furrows and reduced water stress. This led to better crop performance, as plants experienced more favorable growing environment (Choudhary and Bhagawati, 2019).

Impact of land configuration practices and kharif groundnut-based cropping sequence:

Groundnut equivalent yield of rabi crops: The groundnut equivalent yield (GEY) was computed and presented (Table 5). GEY were significantly influenced by different land configuration practices. The highest GEY was recorded with the treatment BBF 150-30cm (12.25 qha⁻¹) and the lowest value was recorded under flatbed (8.89 qha⁻¹). The residual moisture availability under the BBF resulting consecutively higher yield of the respective

crops of the cropping sequences which have attributed to promote higher groundnut equivalent yield of the crops under the said treatments. Similar findings were reported by Tumbare and Bhoite (2000), where maximum chickpea equivalent yield was recorded with ridges and furrow method of sowing over other methods.

The GEY due to different crop sequences varied significantly. The GEY of *kharif* Groundnut-rajmah (15.80 qha⁻¹) was significantly higher over *kharif* Groundnut-pea (10.70 qha⁻¹) and *kharif* Groundnut-toria (5.95 qha⁻¹). It was observed that groundnut being the base and uniform crop, the GEY of different crops of the cropping sequence mostly influenced *kharif* Groundnut-rajmah. Besides, the higher production potential of rajmah as compared to the other *rabi* crops and the better market price of rajmah contributed much for attaining higher GEY under the sequence. It was corroborated with the findings of Reddy and Suresh (2009). According to Pacharne *et al.* (2015) this increase GEY could be attributed to the favorable residual effect of *kharif* groundnut, which fixes atmospheric nitrogen through biological methods and makes it available for mineralization of plant left overs, increasing the yield of the subsequent crop.

Groundnut equivalent yield of the system (q ha⁻¹):

Total system yield was significantly influenced by different land configuration practices (Table 6). System yield was calculated by adding the groundnut yield with the groundnut equivalent yield of the *rabi* crops. The total system yield was found highest in BBF150-30cm(46.13qha⁻¹) and lowest in flatbed (37.95qha⁻¹). Among the sequences *kharif* Groundnut-rajmah performed best (47.26qha⁻¹) which was followed by *kharif* Groundnut- pea sequence. Lowest was observed under *kharif* Groundnut-toria (37.50qha⁻¹). Similar findings were reported by Pacharne *et al.* (2015).

Production efficiency: It was observed that the production efficiency (PE) of different cropping systems due to different land configuration practices had a significant impact (Table 7). The highest value was recorded under BBF150-30cm (23.34kgha⁻¹day⁻¹) and the lowest was under flatbed (19.20 kgha⁻¹day⁻¹).

Table 6: Effect of land configuration practices and crop sequences on System duration and Land utilization index

Treatment	System duration (days)	Land utilization index(%)
Land configuration practices		
M1:BBF90 cm x 30cm	197.33	54.06
M2:BBF120 cm x 30cm	197.33	54.06
M3:BBF150 cm x 30cm	197.33	54.06
M4:Flatbed	197.33	54.06
CD(P=0.05)	NS	NS
Crop sequences		
C1:kharif Groundnut-toria	193	52.88
C2:kharif Groundnut-pea	197	53.97
C3:kharif Groundnut-rajmah	202	55.34
CD(P=0.05)	NS	NS

Table 7: Effect of land configuration practices and crop sequences on Production efficiency and Rain water productivity

Treatment	Production efficiency (kg ha ⁻¹ day ⁻¹)	Rain water productivity (kg ha ⁻¹ mm ⁻¹)
Land configuration practices		
M1:BBF90 cm x 30cm	20.60	6.00
M2:BBF120 cm x 30cm	22.43	6.53
M3:BBF150 cm x 30cm	23.34	6.80
M4:Flatbed	19.20	5.59
SEd+	0.23	0.06
CD(P=0.05)	0.56	0.17
Crop sequences		
C1:kharif Groundnut-toria	19.43	5.53
C2:kharif Groundnut-pea	21.36	6.20
C3:kharif Groundnut-rajmah	23.40	6.96
SEd+	0.28	0.08
CD(P=0.05)	0.60	0.18

The increased yield of individual crops as well as their groundnut equivalent yield under the BBF150-30cm directly had a positive influence in resulting higher production efficiency of the groundnut-based cropping sequence under the said treatment.

The production efficiency due to different cropping sequences differed significantly. Maximum production efficiency of 23.40 kg ha⁻¹ day⁻¹ was recorded under *kharif* Groundnut-rajmah which was significantly superior to the rest of the cropping sequences and *kharif* Groundnut-toria sequence registered the lowest production efficiency (19.43 kg ha⁻¹ day⁻¹). The contributions of groundnut equivalent yield in *kharif* Groundnut-rajmah were quite evident when compared to the other two crops, resulting in the highest production efficiency under the aforementioned cropping sequence. The present findings are in agreement with the findings of Borate *et al.* (2023) where sweetcorn-rajmah

cropping sequence recorded maximum system production efficiency.

Rain water productivity: Different land configuration practices brought about significant variation in rain water productivity of groundnut-based cropping systems (Table7). BBF 150-30 cm (6.80kg ha⁻¹ mm⁻¹) recorded the highest rain water productivity over other treatments. The lowest value of rain water productivity (5.59kg ha⁻¹ mm⁻¹) was recorded under the flatbed. Increased moisture availability and groundnut equivalent yield of different crops under the treatment BBF 150-30 cm might be the reason of higher rain water productivity under the treatment.

Among the different groundnut-based cropping sequences *kharif* Groundnut-rajmah (6.96 kg ha⁻¹ mm⁻¹) registered significantly higher values while *kharif* Groundnut-toria (5.53 kg ha⁻¹ mm⁻¹) showed the lowest rain water productivity. The higher seed yield coupled with more moisture availability might have

attributed to better water productivity in *kharif* Groundnut-rajmah cropping system.

Effect of land configuration practices and cropping sequences on soil moisture content and available NPK : The data pertaining to soil moisture (Table 8) was recorded in *rabi* season at 10 days interval as influenced by different land configuration practices and crop sequence. The soil moisture did not exert any significant variation among the treatment. However, the treatment BBF 90-30cm recorded the highest moisture content followed by BBF120- 30cm and BBF 150-30cm over flat bed. It was depicted by curve (Fig. 1 and 2) which was visualized by variation in the curve with the changes in moisture content during the *rabi* crops period. During that period more conserved moisture was recorded in all the beds irrespective of size as compare to flatbed. Among the broadbed furrows, higher moisture content was observed

under BBF 90-30cm bed size which might be due to a greater number of furrows as compared to other two bed.

It was observed that available nitrogen, phosphorous and potassium content as shown in (Table 9) after end of the cropping sequence due to different land configuration practices differ significantly. Flatbed revealed the highest N, P, K over other treatment and lowest value was observed under BBF 150-30cm which might be due to higher plant nutrient and water uptake as well as yield. Similar findings were reported by Mandal *et al.* (2019) that as the production increased, so did nitrogen uptake, indicating that a combination of higher irrigation regime and soil N treatment resulted in enhanced uptake due to optimal accessible moisture and nitrogen to the groundnut crop.

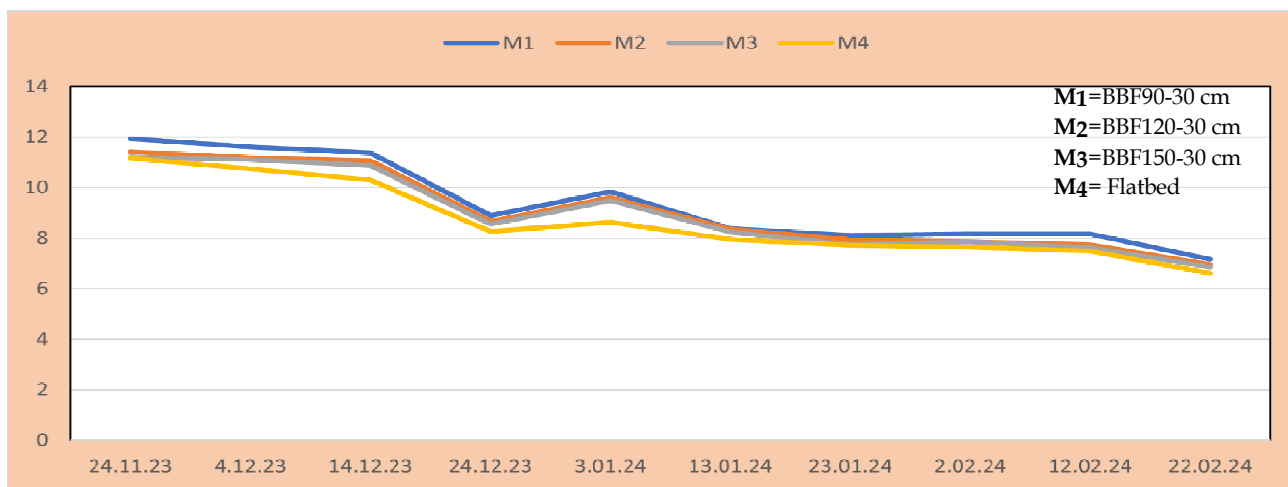


Fig 1: Soilmoisturecontent(%)asinfluencebydifferent land configuration practices

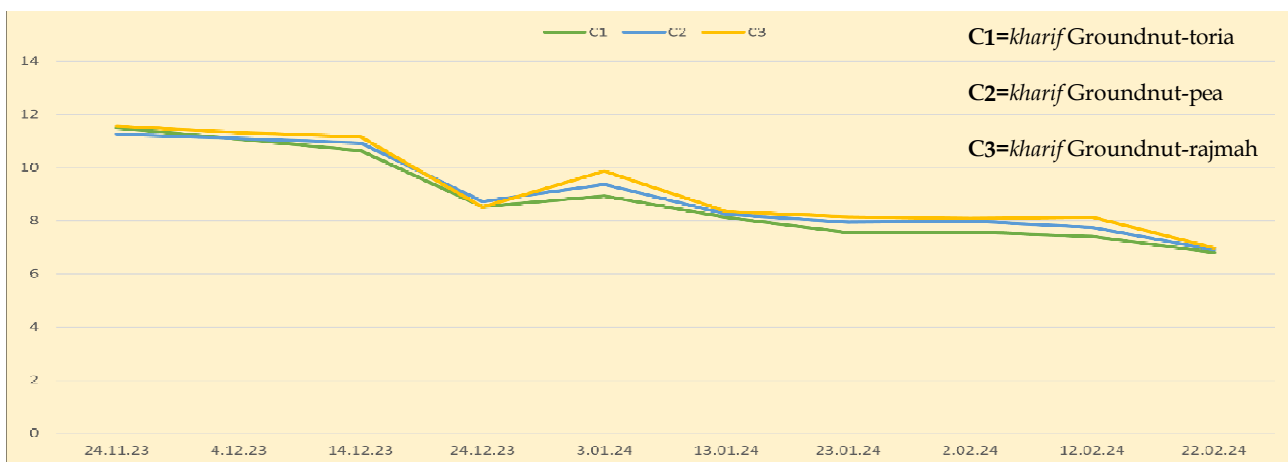


Fig 2 :Soilmoisturecontent(%)asinfluencebydifferent crop sequences

Table 8: Effect of land configuration practices and *kharif* groundnut-based cropping sequences on soil moisture (%) content at 10 days in *rabi* season

Treatment	24.11.23	4.12.23	14.12.23	24.12.23	3.01.24	13.01.24	23.01.24	2.02.24	12.02.24	22.02.24
Land Configuration practices										
M1:BBF90 cm x 30cm	11.94	11.60	11.38	8.89	9.84	8.38	8.11	8.16	8.16	7.16
M2:BBF120cm x 30cm	11.41	11.19	11.07	8.66	9.60	8.35	7.93	7.86	7.75	6.96
M3:BBF150 cm x 30cm	11.21	11.10	10.88	8.54	9.49	8.25	7.74	7.85	7.63	6.86
M4:Flatbed	11.17	10.73	10.29	8.26	8.62	7.96	7.73	7.64	7.49	6.60
SEd+	0.37	0.27	0.56	0.36	0.62	0.34	0.43	0.18	0.26	0.18
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Crop sequences										
C1: <i>kharif</i> Groundnut-toria	11.48	11.07	10.63	8.53	8.93	8.12	7.55	7.57	7.40	6.81
C2: <i>kharif</i> Groundnut-pea	11.25	11.09	10.92	8.72	9.36	8.24	7.94	7.99	7.74	6.90
C3: <i>kharif</i> Groundnut-rajmah	11.56	11.31	11.16	8.51	9.86	8.34	8.15	8.09	8.14	6.98
SEd+	0.25	0.37	0.50	0.25	0.42	0.36	0.31	0.26	0.28	0.17
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 9: Effect of land configuration practices and *kharif* groundnut-based cropping sequences on available nutrient of soil after completion of sequence

Treatment	Available nutrient (kg ha ⁻¹)		
	N	P	K
Land configuration practices			
M1:BBF90cm x 30cm	351.82	11.96	139.87
M2:BBF120cm x 30cm	332.70	9.38	95.83
M3:BBF150cm x 30cm	330.43	8.10	92.64
M4: Flat bed	361.22	12.67	150.76
SEd+	1.27	0.14	1.69
CD(P=0.05)	3.16	0.35	4.22
Crop sequences			
C1: <i>kharif</i> Groundnut-toria	337.69	10.71	119.69
C2: <i>kharif</i> Groundnut-pea	359.79	10.39	119.57
C3: <i>kharif</i> Groundnut-rajmah	334.64	10.49	120.06
SEd+	2.75	0.19	1.36
CD(P=0.05)	5.88	NS	NS

Table 10: Effect of land configuration and crop sequences on monetary return

Treatment	Cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	Economic Efficiency (Rs ha ⁻¹ day ⁻¹)	B:C Ratio
Land configuration practices					
M1:BBF90 cm x 30cm	79,055	2,59,489	1,80,433	913.01	3.28
M2:BBF120 cm x 30cm	77,645	2,82,736	2,05,090	1037.42	3.63
M3:BBF150 cm x 30cm	76,236	2,94,198	2,17,962	1102.56	3.85
M4: Flat bed	72,007	2,42,014	1,70,006	860.00	3.35
Crop sequence					
C1: <i>kharif</i> Groundnut-toria	71,158	2,39,116	1,67,958	870.25	3.36
C2: <i>kharif</i> Groundnut-pea	76,643	2,68,342	1,91,699	973.10	3.50
C3: <i>kharif</i> Groundnut-rajmah	80,908	3,01,369	2,20,461	1091.39	3.72

Price of groundnut: Rs. 6377/q, Price of toria: Rs.4650/q, Price of pea: Rs.7550/q, Price of rajmah: Rs.8000

Different cropping sequences did not significantly affect the available phosphorus or potassium levels at the end of the cropping sequence except for nitrogen (Table 9). Among the cropping sequences, *kharif* groundnut-pea resulted in significantly higher available nitrogen compared to groundnut-toria and groundnut-rajmah. This increase might be attributed to the ability of legumes to enhance soil fertility through a symbiotic association with microorganisms like rhizobia. These microorganisms fix atmospheric nitrogen and make it available to the host plant as well as to subsequent crops through the process of biological nitrogen fixation. It was in agreement with the findings Kebede (2021).

Economics of land configuration practices and kharif groundnut-based cropping sequences: The economics (Table 10) of the *kharif* groundnut-based cropping sequence were significantly impacted by various land configurations. The treatment BBF 90-30cm had the highest cost of cultivation (Rs. 79,055ha⁻¹) followed by BBF120-30cm (Rs.77,645ha⁻¹) and BBF150-30cm(Rs.76,236 ha⁻¹). This was mainly caused by the expense of creating wide bed furrows in accordance with closure, the enlarged bed sizes and the labour requirement. Under flatbed, the lowest cultivation costs were noted (Rs. 72,007 ha⁻¹).

BBF150 30cm registered significantly higher gross return (Rs2,94,198ha⁻¹), net return (Rs 2,17,962 ha⁻¹) and benefit cost ratio (3.85) than other methods of planting. The increased gross return, netreturn and benefit-cost ratio were attributed to higher yields of *kharif* groundnut-rajmah. Similar findings were reported by Borde *et al.* (2022) where broadbed furrow registered the highest economics than conventional method and flatbed method of sowing respectively.

Among the cropping sequences, *kharif* Groundnut-rajmah recorded the highest cost of cultivation (Rs. 80,908 ha⁻¹), gross return (Rs. 3,01,369 ha⁻¹) and net return (Rs. 2,20,461 ha⁻¹). This was followed by the crop sequence *kharif* Groundnut-pea and the lowest cost ofcultivation (Rs.71,158ha⁻¹), gross return (Rs. 2,39,116ha⁻¹) and net return (Rs. 1,67,958 ha⁻¹) was recorded in *kharif* Groundnut-toria. However, the differences in B: C ratios due to different crop sequences, varied from 3.72 in *kharif* Groundnut-rajmah to 3.36 in *kharif* Groundnut-toria. The higher gross and net return under *kharif* Groundnut- rajmah was mainly due to higher

production potential and price of rajmah. According to findings reported by Borate *et al.* (2023) among different cropping sequences, sweetcorn- rajmah cropping sequence contributed higher net returns and B: C ratio.

The economic efficiency was recorded the highest in BBF 150-30cm (Rs. 1102.56 ha⁻¹day⁻¹) followed by BBF 120-30cm and the lowest economic efficiency was recorded in flat bed (Rs. 860.00 ha⁻¹day⁻¹). The higher yield of the individual crops which led to generate higher net returns under the treatment BBF 150-30cm had direct bearings on resulting higher economic efficiency under the said treatments.

Among the crop sequences, *kharif* Groundnut-rajmah (Rs. 1091.39 ha⁻¹day⁻¹) showed the highest economic efficiency compared to other crop sequences which was mainly due to the less cropduration coupled with higher net return of rajmah. Similar findings were also reported by Borate *et al.* (2023). The lowest economic efficiency was obtained under *kharif* Groundnut-toria (Rs. 870.25 ha⁻¹day⁻¹).

Conclusions

Based on the two season of investigation (2023-2024) carried out in the research experimental field of the AICRP on dryland Agriculture, it could be concluded that growing of sequence crops in different land configuration is feasible and economically beneficial. The land configuration practices of broadbed furrow were effective in relation to yield attributes and yield of *kharif* groundnut and different *rabi* crops (toria, pea and rajmah) grown after *kharif* groundnut. Among the beds, the bed size of BBF 150cmx30cm was found best. The practice had not only influenced the crop performance but also helped in conserving soil moisture, soil chemical properties along with higher economic return. The *kharif* groundnut-rajmah was the most performing crop sequence in terms of higher system yield with better production efficiency and economic return which was followed by *kharif* Groundnut-pea sequence. Thus, *kharif* Groundnut-pea could also be advocated as an alternative to rajmah in *rabi* season in rainfed upland situations of Assam.

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