# Climate Resilient Intercropping Systems for Rainfed Red Soils of Karnataka

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**ABSTRACT:** In rainfed and dry regions of southern Karnataka, sole cropping is not much remunerative in the present scenario of climate change in agriculture to fulfill the diverse demands of consumers and burgeoning population. Hence, studies on intercropping systems were conducted in Alanatha cluster of villages in Ramanagara district and Chikkamaranahalli cluster in Bengaluru Rural district from 2010 to 2014 as a part of Operational Research Project (ORP) and National Innovations in Climate Resilient Agriculture (NICRA). In both the locations, finger millet (*Eleusine coracana* L.) + pigeonpea (*Cajanus cajan* L.) (8:2) with moisture conservation furrow between paired rows of pigeonpea intercropping recorded higher yield and economics as compared to the farmers' practices of growing finger millet with *akkadi* crops. In groundnut (*Arachis hypogaea* L.) based cropping, groundnut+ pigeonpea (8:2) intercropping with moisture conservation furrow between paired rows of pigeonpea proved to be the better climate resilient intercropping system with higher yields in red soils of southern Karnataka. Under pulse based cropping systems, pigeonpea + cowpea (*Vigna unguiculata* L.) and pigeonpea + field bean (*Phaseolus vulgaris* L.) were remunerative when grown in additive series compared to sole crop of pigeonpea.

**Key words:** B:C ratio, climate resilience, equivalent yield, intercropping, rain water use efficiency

## Introduction

In India, 60% of total cultivated area is managed as rainfed ecosystem, wherein crop production is dependent on rainfall, having no facility for protective or lifesaving irrigation. India ranks first among the rainfed agricultural countries of the world in terms of both extent and value of produce. Rainfed agriculture supports 40% of the national food demands. These areas receive an annual rainfall between 400 mm and 1000 mm, which is unevenly distributed, highly uncertain and erratic. As a result, a significant fall in food production is often noticed. The rainfed agriculture as such is most impacted by climate change (Asha latha *et al.,* 2012). Rainfall behaviour, temperature fluctuation and wind are becoming routine aberrations under rainfed ecosystem because of climate change. Added to this, reduced number of rainy days and increased rainfall intensity resulting in heavy crop losses need serious attention to bring stability of rainfed ecosystems.

Intercropping is an important aspect to combat the crop failure in rainfed agriculture under the situation of climate change and helps in improving productivity and profitability through efficient utilization of natural resources. Intercropping provides insurance against drought, modifies soil environment, improves moisture and radiation use, ensures better weed control, reduces disease and pest incidence and on the whole increases and stabilizes the productivity. Intercropping has been identified as a kind of biological insurance against risks under aberrant rainfall behavior. Crop diversification is also necessary to get higher yield and return besides maintaining soil health apart from other benefits (Siddique *et al.,* 2012). In this regard, study was undertaken to evaluate different cereal, pulse and oilseed based intercropping systems in selected villages of Karnataka.

## Materials and Methods

### Selection of site

Two demonstration sites covering two districts *viz*., Bengaluru Rural and Ramanagara from Karnataka state were selected for the study. The steps for selection of villages in different districts include climatic constraints of the area, assessment of natural resources, farming situations, constrains in crop production, climatic vulnerability, yield gaps and opportunities for adaptations to climate change. Action plans to demonstrate appropriate intercropping systems to mitigate the climatic vulnerability preferably drought was implemented in farmers' fields in a participatory research mode involving scientists under Operational Research Project (ORP) and National Innovations in Climate Resilient agriculture (NICRA). The details of villages selected for the purpose of study along with soil types and normal rainfall and climate vulne*rabi*lities are presented in Table 1.

**Table 1 : Site characteristics of NICRA and ORP villages**

| District | NICRA/ ORP village | Soil type | Annual rainfall (mm) | Climate variability |
|---|---|---|---|---|
| Ramanagara | Alanatha cluster (Alanatha, Mahadevpura, Eregowdanadoddi, Arjunahalli, Arjunahallitandya) | Red sandy clay loam | 756.0 | Drought |
| Bengaluru Rural | (Chikkamaranahalli, Chikkamaranahalli colony, Chikkaputtayyanapalya, Mudalapalya and Hosapalya) | Red sandy clay loam | 913.8 | Drought |

The demonstration of improved intercropping systems along with sole crops and *akkadi* cropping were conducted in farmers' fields in the selected districts (Table 2). Farmers in the demonstration villages were selected based on their willingness to engage in participatory research. Before conducting the demonstrations, list of farmers was prepared in group meetings and specific skill training was given to the selected farmers during pre-*kharif*. Selected farmers participated in each and every research intervention from soil sampling to harvest. Timely sowing, maintenance of required spacing and plant population, timely weeding and plant protection were attended as per the instructions of scientists.

## Climatic conditions

In Alanatha village cluster of Ramanagara district during 2010, 797.2 mm rainfall was received in 41 rainy days, as against normal rainfall of 756 mm in 48 rainy days which was 5% lower than the normal. During 2011, rainfall pattern was highly erratic and uneven with 882 mm rainfall received in 37 rainy days. About 41% of the rainfall was received during April-May months itself. Non receipt of rainfall in June and July resulted in delayed sowing of crops. In 2012, rainfall distribution was very poor (494 mm in 23 rainy days), a 35% less than normal. During 2013, 848.4 mm rainfall was received in 58 rainy days which was 12% higher than the normal. Annual rainfall of 653.4 mm was received during 2014 in 32 rainy days which was less than the normal. Overall out of 5 years of studies the rainfall was normal in three years and deficit in two years.

In Chikkamaranahalli village cluster of Nelamangala taluk, the total rainfall received during 2011 was 692 mm in 36 rainy days which was 15% less than the normal. In 2012, 442 mm of rainfall was received in 26 rainy days, as against normal rainfall of 750 mm in 46 rainy days (30% low). During 2013, an amount of 651 mm of rainfall was received in 36 rainy days, accounting for 12% deficit. In 2014, total rainfall received was 949.0 mm in 52 rainy days (more than the normal rainfall). In an assessment of intercropping system, finger millet + pigeonpea (8:2), groundnut + pigeonpea (8:2), groundnut + castor (8:1), pigeonpea + cowpea (1:1) and pigeonpea + field bean (1:1) were demonstrated in participatory mode under ORP and NICRA

**Table 2 : Area and number of farmers under different cropping systems**

| Cropping system | District | Year | Number of farmers | Area (ha) |
|---|---|---|---|---|
| Finger millet + Pigeonpea (8:2) | Ramanagara | 2010 | 37 | 16.20 |
| | | 2011 | 38 | 19.65 |
| | | 2012 | 33 | 18.40 |
| | | 2013 | 40 | 16.20 |
| | | 2014 | 54 | 26.20 |
| | Bengaluru Rural | 2011 | 59 | 27.65 |
| | | 2014 | 74 | 13.50 |
| Groundnut + Pigeonpea (8:2) | Ramanagara | 2010 | 9 | 3.20 |
| | | 2011 | 18 | 8.50 |
| | | 2012 | 10 | 4.50 |
| | | 2013 | 5 | 4.00 |
| | | 2014 | 23 | 13.40 |
| | Bengaluru Rural | 2011 | 8 | 5.60 |
| | | 2012 | 12 | 9.20 |
| | | 2014 | 15 | 3.80 |
| Pigeonpea + Field bean/ cowpea (1:1) | Ramanagara | 2010 | 4 | 1.60 |
| | | 2011 | 6 | 2.40 |
| | | 2012 | 1 | 0.40 |
| | | 2013 | 2 | 0.80 |
| | Bengaluru Rural | 2011 | 8 | 2.50 |
| | | 2012 | 9 | 2.56 |
| | | 2013 | 2 | 1.40 |
| | | 2014 | 3 | 0.80 |

involving 490 farmers in 211 ha in red soils of Alanatha cluster village of Ramanagara district and Chikkamaranahalli cluster villages in Bengaluru Rural district of Karnataka from 2010 to 2014.

**Observations**

The yield observations were recorded at harvest of the respective crops. The yields of intercrops were converted into main crop equivalent yields taking into account the actual yields (kg/ha) attained by crops along with the prices (per kg) of the crops. The data were subjected to "t" test analysis for determining its significance between the treatments and to draw valid conclusions. The level of significance used was 5%. The rainwater use efficiency (kg/ha-mm) of a crop or cropping system was determined by considering the crop equivalent yield (kg/ha) attained by the system and crop seasonal rainfall (mm) received from sowing to harvest of a given crop or the long duration crop in the cropping system. It is given as a ratio of the crop equivalent yield to that of crop seasonal rainfall. The cost of cultivation (₹/ha) incurred under different cropping systems was derived by taking into account all the costs involved for different agricultural inputs and operations. The values of different crops in sole and intercropping systems were considered to derive the gross returns (₹/ha).The prices of farm produce in different years are presented in Table 3.

$$\text{Crop equivalent yield (kg/ha)} = \text{Yield of main crop (kg/ ha)} + \left\{ \frac{\text{Yield of inter crop (kg/ha)} \times \text{Price of inter crop (Rs/kg)}}{\text{Price of main crop (Rs/kg)}} \right\}$$

## Results and Discussion

**Finger millet based intercropping system**

Under ORP in five cluster villages of Alanatha in Ramanagara district, intercropping of finger millet + pigeon pea (8:2) recorded higher finger millet grain equivalent yield by 2354, 1946, 1368,1798 and 911 kg/ha than farmer practice of finger millet + *akkadi* cropping system during 2010, 2011, 2012, 2013 and 2014, respectively. On an average, the intercropping system of finger millet + pigeonpea (8:2) recorded significantly higher finger millet grain equivalent yield (3156 kg/ha) and B:C ratio (3.13) as compared to finger millet + *akkadi* (Table 4). Similar observations were also recorded under NICRA in Nelamangala taluk of Bengaluru Rural district with significantly higher finger millet grain equivalent yield in all the years of study with a mean of 3415 kg/ha and B: C ratio 3.08 (Table 5). The per cent increase in yield was 65. Highest rain water use efficiency (7.24 and 5.77 kg/ha-mm, ORP and NICRA, respectively) was observed with finger millet + pigeonpea intercropping system compared to finger millet + *akkadi*. This was attributed to the better performance of small millets even under drought and erratic rainfall, both as sole crop and intercrop probably due to their drought tolerance (Shashidhara *et al.,* 2000). Adikant Pradhan *et al.* (2014) reported that finger millet intercropping recorded the best yield as compared to the sole in terms of monetary returns.

**Groundnut based intercropping system**

In Ramanagara district, groundnut + pigeonpea (8:2) and groundnut + castor (8:1) intercropping systems recorded significantly higher mean groundnut equivalent yields (1007 and 820kg/ha, respectively) compared to groundnut + *akkadi* cropping (Table 6). Though there was high rainfall in the year 2013, drought prevailed during pod filling stage leading to yield reduction. In 2014, dryspell during initial stage of crop lead to synchronized flowering and good rainfall during pod filling stage resulted in higher groundnut yield. Similar results of increased yield were observed in peanut due to early season drought which was due to root growth (Jongrungklang *et al.,* 2011). Also, rain water use efficiency, net returns and B: C ratio were highest (2.18 kg/ha-mm, ₹ 18842/ha and 1.96, respectively) in groundnut + pigeonpea (8:2) compared to other cropping systems. Similarly, in Bengaluru Rural district at NICRA site, higher groundnut pod equivalent yields were recorded (2072, 718 and 1383 kg/ha during 2011, 2012 and 2014, respectively) with a mean of 1391 kg/ha which was significantly higher compared to groundnut + *akkadi* cropping system (Table 7). Furthermore, higher rain water use efficiency (2.54 kg/ha-mm), net returns (₹ 18842/ha) and B: C ratio (1.96) was recorded in groundnut + pigeonpea (8:2) intercropping system. In pigeonpea + groundnut intercropping system, the increase in yield might be due to no or low competition between main crop and intercrop for growth, development and for above ground and below ground resources as groundnut crop was of shorter duration and non-spreading nature and further, might be due to complementarity in resource utilization by groundnut crop (Ramesh and Devasenapathy, 2007).

**Table 3 : Price of agriculture produce during the years of study**

| Produce | Price (₹/kg) | | | | |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 |
| Finger millet (*Eleusine coracana* L.) | 10.0 | 11.0 | 20.0 | 20.0 | 25.0 |
| Pigeonpea (*Cajanus cajan* L.) | 35.0 | 35.0 | 40.0 | 43.0 | 43.0 |
| Groundnut(*Arachis hypogaea* L.) | 28.0 | 28.0 | 50.0 | 50.0 | 60.0 |
| Field bean (*Phaseolus vulgaris* L.) | 30.0 | 30.0 | 30.0 | 25.0 | 50.0 |
| Cowpea (*Vigna unguiculata* L.) | 30.0 | 30.0 | 30.0 | 50.0 | 50.0 |
| Sorghum (*Sorghum bicolor* L.) | 16.0 | 16.0 | 16.0 | 16.0 | 20.0 |
| Castor (*Ricinus communis* L.) | 22.0 | 35.0 | 35.0 | 40.0 | 40.0 |

**Table 4 : Yield and economics of finger millet based intercropping system in *alfisols* of Ramanagara district (Karnataka)**

| Years | Treatments | Yield of main crop (kg/ha) | | Yield of intercrop (kg/ha) | FM Grain equivalent yield (kg/ha) | RWUE (kg/ha-mm) | Returns (₹/ha) | | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|
| | | Grain | Straw | | | | Gross | Net | |
| 2010 | Finger millet + pigeonpea | 3171 | 8403 | 480 | 4291 | 10.19 | 54812 | 40312 | 3.78 |
| | Finger millet + *akkadi* | 1550 | 2868 | PP-70, Cas-40 Sor -10, FB-50 | 1937 | 9.02 | 22641 | 12221 | 1.97 |
| 2011 | Finger millet + pigeonpea | 2195 | 5490 | 334 | 3257 | 6.96 | 39952 | 24952 | 2.66 |
| | Finger millet + *akkadi* | 1090 | 2725 | PP-37, Cas-15 Sor-7, FB-17 | 1311 | 4.87 | 15827 | 5327 | 1.50 |
| 2012 | Finger millet + pigeonpea | 2270 | 5040 | 180 | 2630 | 7.62 | 56380 | 40820 | 3.62 |
| | Finger millet + *akkadi* | 1190 | 2490 | PP-17, Cas-10 Sor-7, FB-10 | 1262 | 6.87 | 25668 | 10968 | 1.75 |
| 2013 | Finger millet + pigeonpea | 2665 | 5705 | 202 | 3313 | 6.50 | 66267 | 45688 | 3.22 |
| | Finger millet + *akkadi* | 1320 | 2579 | PP-19, Cas-15 Sor-12, FB-14 | 1515 | 5.05 | 30292 | 14992 | 1.98 |
| 2014 | Finger millet + pigeonpea | 1979 | 4740 | 180 | 2289 | 5.25 | 60770 | 35179 | 2.37 |
| | Finger millet + *akkadi* | 1287 | 2565 | PP-17, Cas-12 Sor-8, FB-18 | 1378 | 5.19 | 36370 | 9704 | 1.36 |
| Mean | Finger millet + pigeonpea | 2456 | 5876 | 275 | 3156 | 7.24 | 51636 | 37390 | 3.13 |
| | Finger millet + *akkadi* | 1287 | 2651 | PP-25, Cas-18 Sor-9, FB-22 | 1481 | 6.10 | 26160 | 10642 | 1.71 |
| t-value for finger millet grain equivalent yield | | | | | 31.62* | | | | |

PP: Pigeonpea; Cas: Castor; Sor: Sorghum; FB: Field bean, FM: Finger millet; RWUE: Rain water use efficiency

**Table 5 : Yield and economics of finger millet based intercropping system in *alfisols* of Bengaluru Rural district (Karnataka)**

| Year | Treatments | Finger millet yield (kg/ha) | | Intercrop yield (kg/ha) | FM Grain equivalent yield(kg/ha) | RWUE (kg/ha-mm) | Net returns (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| | | Grain | Straw | | | | | |
| 2011 | Finger millet + pigeonpea | 2667 | 5120 | 417 | 3993 | 6.85 | 32763 | 3.18 |
| | Finger millet + *akkadi* | 1894 | 5940 | - | 1894 | 3.25 | 11989 | 1.90 |
| 2014 | Finger millet + pigeonpea | 2389 | 4076 | 260 | 2836 | 4.71 | 47088 | 2.98 |
| | Finger millet + *akkadi* | 2250 | 3750 | - | 2250 | 3.73 | 35247 | 2.48 |
| Mean | Finger millet + pigeonpea | 2528 | 4598 | 339 | 3415 | 5.77 | 34005 | 3.08 |
| | Finger millet + *akkadi* | 2072 | 4845 | - | 2072 | 3.50 | 23618 | 2.19 |
| t-value for finger millet grain equivalent yield | | | | | 47.89* | | | |

FM: Finger millet; RWUE: Rain water use efficiency

**Table 6 : Yield and economics of groundnut based intercropping system in *alfisols* of Ramanagara district (Karnataka)**

| Year | Treatments | Yield (kg/ha) | | Groundnut equivalent yield (kg/ha) | RWUE (kg/ha-mm) | Net returns (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| | | Main crop | Intercrop | | | | |
| 2010 | Groundnut + pigeonpea | 790 | 645 | 1596 | 3.45 | 29290 | 2.72 |
| | Groundnut + castor | 885 | 440 | 1435 | 3.10 | 19730 | 2.20 |
| | Groundnut + *akkadi* | 650 | PP-110, Cas-80, Sor-30, FB-60 | 969 | 2.09 | 13550 | 1.97 |
| 2011 | Groundnut + pigeonpea | 780 | 580 | 1505 | 3.02 | 26140 | 2.49 |
| | Groundnut + castor | 805 | 320 | 1205 | 2.42 | 18665 | 2.12 |
| | Groundnut + *akkadi* | 505 | PP-98, Cas-72, Sor-22, FB-55 | 832 | 1.67 | 9860 | 1.68 |
| 2012 | Groundnut + pigeonpea | 310 | 210 | 478 | 1.39 | 7960 | 1.48 |
| | Groundnut + castor | 340 | 32 | 362 | 1.05 | 3955 | 1.27 |
| | Groundnut + *akkadi* | 275 | PP-40, Cas-15, Sor-30, FB-25 | 344 | 1.00 | 1591 | 1.10 |
| 2013 | Groundnut + pigeonpea | 325 | 196 | 504 | 0.91 | 7,907 | 1.46 |
| | Groundnut + castor | 363 | 70 | 430 | 0.78 | 6,216 | 1.41 |
| | Groundnut + *akkadi* | 218 | PP-22, Cas-13, Sor-14, FB-19 | 257 | 0.46 | -3225 | 0.99 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2014 | Groundnut + pigeonpea | 600 | 492 | 953 | 2.14 | 22,914 | 1.66 |
| | Groundnut + castor | 611 | 84 | 667 | 1.50 | 5796 | 1.17 |
| | Groundnut + *akkadi* | 570 | PP-30, Cas-20, Sor-16, FB-23 | 629 | 1.41 | 2513 | 1.07 |
| Mean | Groundnut + pigeonpea | 561 | 425 | 1007 | 2.18 | 18842 | 1.96 |
| | Groundnut + castor | 596 | 189 | 820 | 1.78 | 10872 | 1.63 |
| | Groundnut + *akkadi* | 444 | PP-60, Cas-40, Sor-18, FB-25 | 440 | 0.95 | 4858 | 1.36 |
| t-value for groundnut equivalent yield | | | | 11.79* | | | |

PP: Pigeonpea; Cas: Castor; Sor: Sorghum; FB:Field bean; RWUE: Rain water use efficiency

**Table 7 : Yield and economics of groundnut based intercropping system in *alfisols* of Bengaluru Rural district (Karnataka)**

| Year | Treatment | Yield (kg/ha) | | Groundnut equivalent yield (kg/ha) | RWUE (kg/ha-mm) | Net returns (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| | | Main crop | Inter crop | | | | |
| 2011 | Groundnut + pigeonpea | 792 | 913 | 2072 | 3.55 | 34290 | 2.95 |
| | Groundnut + *akkadi* | 547 | - | 547 | 0.94 | 6416 | 1.44 |
| 2012 | Groundnut + pigeonpea | 418 | 375 | 718 | 2.14 | 17950 | 2.00 |
| | Groundnut + *akkadi* | 382 | - | 382 | 1.53 | 1600 | 1.09 |
| 2014 | Groundnut + pigeonpea | 1192 | 267 | 1383 | 1.92 | 48219 | 2.39 |
| | Groundnut + *akkadi* | 793 | - | 793 | 1.10 | 13552 | 1.40 |
| Mean | Groundnut + pigeonpea | 801 | 518 | 1391 | 2.54 | 33486 | 2.45 |
| | Groundnut + *akkadi* | 574 | - | 574 | 1.05 | 7189 | 1.31 |
| t-value for groundnut equivalent yield | | | | 24.73* | | | |

RWUE: Rain water use efficiency

**Pigeonpea based intercropping system**

In pigeonpea based intercropping, pigeonpea + field bean (1:1) recorded significantly higher pigeonpea equivalent yield (1028 kg/ha) compared to sole cropping of pigeonpea in ORP villages (Table 8). Under NICRA, pigeonpea + cowpea (1:1) and pigeonpea + field bean (1:1) intercropping systems recorded significantly higher mean pigeonpea grain equivalent yields (1223 and 863 kg/ha, respectively) and B: C ratio (2.53 and 2.84, respectively) over sole crop of pigeonpea (Table 8). In both the locations, pigeonpea + field bean (1:1) cropping system recorded higher rain water use efficiency compared to sole pigeonpea crop. Similar results of higher yields were obtained in pigeonpea + green gram due to better utilization of resources (Sharma Arjun *et al.,* 2004; Subba Reddy *et al.,* 2004. Kathmale *et al.,* 2014) reported that, the legumes as intercrops act as cover crops in wider row spaced pigeonpea resulting in higher *in-situ* moisture conservation and efficient utilization by both the component crops, furthermore helping in increased pigeonpea equivalent yields and RWUE.

**Table 8 : Yield and economics of pigeonpea based intercropping system in *alfisols* of Ramanagara district (Karnataka)**

| Year | Treatment | Grain yield (kg/ha) | | Pigeonpea equi. yield (kg/ha) | RWUE (kg/ha-mm) | Net returns (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| | | Main crop | Inter crop | | | | |
| 2010 | Pigeonpea + fieldbean | 970 | 460 | 1365 | 2.95 | 39030 | 4.12 |
| | Pigeonpea | 1050 | - | 1050 | 2.27 | 26500 | 3.15 |
| 2011 | Pigeonpea + field bean | 790 | 275 | 1067 | 2.14 | 26280 | 3.08 |
| | Pigeonpea | 990 | - | 990 | 1.99 | 24180 | 2.95 |
| 2012 | Pigeonpea + field bean | 640 | 220 | 805 | 2.33 | 21,103 | 2.65 |
| | Pigeonpea | 780 | - | 780 | 2.26 | 19,805 | 2.55 |
| 2013 | Pigeonpea + field bean | 700 | 226 | 873 | 1.98 | 24,625 | 2.93 |
| | Pigeonpea | 820 | - | 820 | 1.86 | 23,665 | 2.88 |
| Mean | Pigeonpea + field bean | 775 | 295 | 1028 | 2.19 | 27760 | 3.20 |
| | Pigeonpea | 910 | - | 910 | 1.94 | 23538 | 2.88 |
| t-value for pigeonpea equivalent yield | | | | 10.74* | | | |

RWUE: Rain water use efficiency

**Table 9 : Yield and economics of pigeonpea based intercropping system in *alfisols* of Bengaluru Rural district (Karnataka)**

| Year | Treatment | Grain yield (kg/ha) | | Pigeonpea equivalent yield (kg/ha) | RWUE (kg/ha-mm) | Net returns (₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| | | Main crop | Inter crop | | | | |
| 2011 | Pigeonpea + cowpea | 1212 | 200 | 1383 | 2.37 | 35805 | 3.84 |
| | Pigeonpea + field bean | 842 | 416 | 1199 | 2.060 | 29165 | 3.27 |
| | Sole pigeonpea | 476 | - | 476 | 0.817 | 4260 | 1.34 |
| 2013 | Pigeonpea + cowpea | 654 | 516 | 954 | 2.12 | 17566 | 1.75 |
| | Sole pigeonpea | 640 | - | 640 | 1.42 | 6398 | 1.30 |
| 2014 | Pigeonpea + cowpea | 750 | 500 | 1331 | 1.79 | 28428 | 1.99 |
| | Pigeonpea + field bean | 850 | 650 | 1606 | 2.15 | 39978 | 2.40 |
| | Sole pigeonpea | 825 | - | 825 | 1.04 | 8933 | 1.34 |
| Mean | Pigeonpea + cowpea | 872 | 405 | 1223 | 2.09 | 27266 | 2.53 |
| | Pigeonpea + field bean | 846 | 533 | 863 | 2.10 | 34572 | 2.84 |
| | Sole pigeonpea | 647 | - | 647 | 1.09 | 6530 | 1.33 |
| | t-value for pigeonpea equivalent yield | | | 12.28* | | | |

RWUE: Rain water use efficiency

## Conclusion

In an assessment of different intercropping systems in red soils of Ramanagara and Bengaluru Rural districts, finger millet + pigeonpea (8:2), groundnut + pigeonpea (8:2) and pigeonpea + field bean/cowpea (1:1) were found to be economical and climate resilient in dryland situations. Hence, intercropping system offers solution to obtain higher productivity, diversified food products and reduced risk of crop failure under rainfed conditions.

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