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Efficient Food-Fodder Production System Involving Cassava

Cassava is the most important tuber crop of Kerala which forms an integral part of most of the cropping systems in the state. The crop is mainly grown as rainfed in marginal uplands. It has high capacity for carbohydrate production per unit area. Since the development of cassava in initial stages is very slow, a sole crop of cassava does not efficiently use the available land, light, water and nutrient resources, during its early developmental stages. Therefore, a short-duration crop can be integrated in the system to make more efficient use of land and other growth factors (Ravi and Mohankumar, 2004). Intercropping cassava and fodder grasses with extensive fibrous root system helps to reduce soil erosion, leaching of nutrients and decline in soil fertility. Similarly integration of fodder legumes in cassava based cropping system can provide protection against runoff and erosion and also at the same time can enhance the yield of succeeding crop due to the nutrient contribution from the residues. The association of arbuscular mycorrhizal fungi (AMF) with plant roots, through acquisition of phosphates and other mineral nutrients from soil by the fungus is recognized as a key component of a healthy and productive agricultural system. With this background, the present study was undertaken with the objective to find out a suitable cassava based fodder production system for the uplands of Kerala.

A field experiment was conducted to assess the biological and economic suitability of intercropping fodder grasses and legumes in cassava for food-fodder production and to study the response of the system to AMF application at the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India, during 2009. The experiment with 14 treatments was laid out in randomized block design with three replications.

The treatments were:

T_1 : Cassava + bajra napier (BN) hybrid
T_2 : Cassava + BN hybrid + AMF
T_3 : Cassava + palisade grass
T_4 : Cassava + palisade grass + AMF
T_5 : Cassava + fodder cowpea
T_6 : Cassava + fodder cowpea + AMF
T_7 : Cassava + BN hybrid + fodder cowpea
T_8 : Cassava + BN hybrid + fodder cowpea + AMF
T_9 : Cassava + palisade grass + fodder cowpea
T_{10}: Cassava + palisade grass + fodder cowpea + AMF
T_{11}: Sole crop of cassava
T_{12}: Sole crop of BN hybrid
T_{13}: Sole crop of palisade grass
T_{14}: Sole crop of fodder cowpea

Cassava var. Vellayani Hraswa was planted in paired rows at a spacing of 60/120 x 90 cm. A spacing of 120 cm was given between two such paired rows, 60 cm between the pair rows and 90 cm between plants within a row. Cassava setts were planted vertically on top of the mounds at a depth of 3-4 cm. Fodder grasses and fodder cowpea were raised in the alleys formed between paired rows of cassava. Setts of BN hybrid var. Suguna (*Pennisetum typhoides x Pennisetum purpureum*) were planted in the channels taken in the alleys of cassava @ 1 sett per hill, at a spacing of 60 x 60 cm. Slips of palisade grass (*Brachiaria brizantha*) were planted in the channels taken in the alleys of cassava @ 2 slips per hill at a spacing of 60 x 60 cm. Seeds of fodder cowpea (*Vigna unguiculata*) were sown @ 2 seeds per hole at a spacing of 30 x 15 cm in the alleys of cassava as well as between the rows of fodder grasses as per the treatments.

A uniform dose of FYM @ 12.5 t ha^{-1} was applied as basal and well incorporated into the soil. Fertilizers were applied for cassava, fodder grasses and fodder cowpea as per the package of practices recommendations (KAU, 2007). Slurry of the AMF culture was prepared for dipping the fodder grass setts @ 3 g inoculum per sett. Cassava setts were planted above the thin layer of AMF in plots with AMF application. Slips of grasses treated with AMF were used for planting in the plots with AMF application. Fodder cowpea seeds were sown just above the thin layer of AMF and then covered with soil.

The soil of the experimental site was red sandy clay loam (oxisol, Vellayani series). The soil was high in organic C (0.83%), available P (50.35 kg ha^{-1}), medium in available N (341 kg ha^{-1}) and low in available K (99.76 kg ha^{-1}) with slightly acidic (pH 5.2) soil reaction. The total amount of rainfall received during the cropping season was 1191.9 mm with maximum temperature in the range of 29.6-30.7^{o}C and the minimum of 23.7-24.2^{o}C. The relative humidity that prevailed during the period was 84.6-88.1%.

Cassava was harvested at 184 days after planting (DAP). Two cuts were taken for BN hybrid and palisade grass with the first harvest at 75 DAP and the second at 140 DAP. First crop of fodder cowpea was harvested at 54 days after sowing (DAS) and the second crop at 82 DAS. Observations on tuber yield and green fodder yield were recorded. The crude protein yield, biological and economic efficiency of the system was also analysed.

Tuber yield was significantly influenced by the treatments (Table 1). Sole cassava produced highest tuber yield (22.95 t ha^{-1}), which was on par with T_6 (16.00 t ha^{-1}). The alley crop combinations of T_6 (16.00 t ha^{-1}), T_9 (12.88 t ha^{-1}), T_{10} (12.10 t ha^{-1}), T_5 (12.02 t ha^{-1}), T_3 (9.40 t ha^{-1}) and T_7 (8.66 t ha^{-1}) were on par. Increased yield in pure crop of cassava compared to intercropped cassava was also reported by earlier workers (Anilkumar, 1984; Karnik et al., 1993; Udoh and Ndaeyo, 2000 and Amanullah et al., 2006). Highest tuber yield in sole cassava may be attributed to the production of more number of tubers and increased length of tubers in sole cassava. This may be due to the absence of competition for utilization of water, nutrients, light etc. in sole crop. Also at the time of harvest, sole cassava had maximum height, number of leaves and leaf area index, resulting in increased photosynthesis and accumulation of more photosynthates in the tubers.

Beneficial effect of fodder cowpea and AMF had resulted in better tuber yield of cassava in cassava + fodder

Table 1. Biological and economic efficiency of the food-fodder system

Treatments	Tuber yield (t ha^{-1})	Green fodder yield (t ha^{-1})	Cassava equivalent yield (t ha^{-1})	Crude protein yield (t ha^{-1})	Cassava equivalent income (` ha^{-1})	B: C ratio
T_1	6.34	24.28	13.62	0.32	68108	1.06
T_2	8.39	23.22	15.38	0.23	76946	1.08
T_3	9.40	18.98	15.09	0.34	75491	1.23
T_4	6.13	17.35	11.33	0.29	56670	0.89
T_5	12.02	-	15.57	0.29	77883	1.23
T_6	16.00	-	20.01	0.25	100033	1.40
T_7	8.66	23.98	16.51	0.31	82558	1.20
T_8	7.49	21.90	14.73	0.29	73671	0.99
T_9	12.88	20.14	19.78	0.59	98936	1.52
T_{10}	12.10	16.69	17.97	0.29	89855	1.25
T_{11}	22.95	-	22.95	-	114766	2.28
T_{12}	-	27.22	8.16	0.46	40830	1.30
T_{13}	-	22.34	6.70	0.48	33515	1.49
T_{14}	-	-	5.24	0.46	26426	1.00
CD (0.05)	7.367	NS	6.304	0.136	31536	0.451

cowpea + AMF treatment. This may be due to the higher uptake of nutrients by cassava when grown along with fodder cowpea.

When palisade grass + fodder cowpea was alley cropped in cassava, the tuber yield reduction was only 43.9% (T_9). Among the fodder grasses, cassava grown along with BN hybrid produced comparatively low yield. There was 62.26% reduction in tuber yield of cassava due to BN hybrid + fodder cowpea alley cropping (T_7). This may be due to high shading effect by the vigorous growth of the grass which is evident from the lesser number of tubers and other yield attributes compared to that produced in cassava + palisade grass plots. Hence palisade grass is a better fodder grass component for alley cropping in cassava compared to BN hybrid.

The total green fodder yield did not differ significantly. Maximum green fodder yield (27.22 t ha^{-1}) was obtained for T_{12} (sole BN hybrid). In sole crop, yield was high due to more favourable conditions in the absence of competition for light, nutrients etc.

In the case of BN hybrid with AMF, the presence of AM fungi increased the availability of nutrients, nutrient uptake and thereby promoted better growth of the grass resulting in production of same yield as the sole crop. This is evident from the highest plant height and tiller production in T_2, which might have contributed to the yield. In the cassava based alley cropping system, BN hybrid is reported to be a high yielder than palisade grass. Njoka-Njiru et al. (2006), Katoch and Marwah (2006) and Reddy and Naik (1999) obtained similar results.

The cassava equivalent yield of T_6 (cassava + fodder cowpea + AMF) and T_9 (cassava + palisade grass + fodder cowpea) were on par with sole cassava yield, T_{11} (22.95 t ha^{-1}). The performance of T_9 was also significantly superior in the production of crude protein yield (0.59 t ha^{-1}). The income from sole cassava (T_{11}) was the highest (` 1,14,766 $ha^{-1}$) and was on par with the cassava equivalent income from $T_6$ (` 1,00,033ha^{-1}), T_9 (` 98,936 $ha^{-1}$) and $T_{10}$ (` 89,855 ha^{-1}). Significantly higher B:C ratio of 2.28 was obtained for sole cassava (T_{11}), followed by T_9 (cassava + palisade grass + fodder cowpea) with B:C ratio of 1.52. Similar results were obtained by Bai et al. (1992), Jayakumar (1997), Amanullah et al. (2007) and Polthane et al. (2007).

On the whole, the biological productivity and economic efficiency were highest in the sole crop of cassava, which was on par with alley cropping systems, cassava + fodder cowpea and cassava + palisade grass + fodder cowpea. Alley cropping cassava with palisade grass and fodder cowpea resulted in significantly higher crude protein yield.

Considering the total biological productivity, quality and economic efficiency, the alley crop combination, cassava + palisade grass + fodder cowpea was found to be more efficient for food-fodder production in the uplands of Kerala.

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