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Effect of economics and energetic of different rice based cropping system in inceptisols (Matasi) under irrigated condition

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Abstract

An area experiments with ten cropping structures have been evaluated at Pt. SKS university of Agriculture and studies Station, Surgi Rajnandgaon Chhattisgarh at some point of consecutive kharif- rabi - Zaid seasons of 2018-2019 and 2019-2020. The cropping structures have been evaluated for his or her productivity and determine their effect of various rice based cropping systems on the on land and employment technology efficiency in inceptisols (Matasi) beneath irrigated situation. The land was occupied for optimum length of by way of rice - garlic - cowpea at some stage in both the years and on mean basis while the most labour engagement turned into recorded under rice - coriander (leaf) - sweet potato cropping machine.

Keywords: Rice-based, Lue and employment generation efficiency

Introduction

Most of the rural fields in sub-humid Japanese place of India (Jap Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa. Madhya Pradesh and Chhattisgarh) practice rice- fallow cropping gadget. Chhattisgarh is popularly recognized as rice bowl of the U. S. A. as rice is the primary crop of this country in all styles of land situations i.e upland, midland and lowland. The cropping depth of Chhattisgarh state is 137% (Nameless 2022). The kharif rice included about sixty nine.70% of general net sown area of the nation and throughout Rabi its miles cultivated in round sixteen.00 lakh hectares. Fields are visible fallow in uplands because of insufficient water availability at the same time as, in low lands because of immoderate wetness and stickiness after rice harvest proscribing tillage operation because of heavy texture & negative drainage facility (Raman, 2008) ^[7]. Internet sown vicinity in wintry weather (Rabi) and summer time after kharif rice is growing underneath irrigated mid land situations because of growth in place beneath minor and foremost irrigation projects in Chhattisgarh.

Rice-Rice system is the most dominant cropping series in irrigated ecology of the Chhattisgarh. Continuous cultivation of rice for longer duration resulted low system productiveness therefore reduces soil fertility because of emergence of multiple nutrient deficiencies. This device deteriorates the soil physio-chemical residences and decline crop yield in addition to average productivity in excessive productiveness areas. During rice cultivation, soil undergoes drastic adjustments i.e. aerobic to anaerobic surroundings leading to several bodily and electro-chemical adjustments. Puddling breaks capillary pores reduces void ratio, destroy soil aggregates, disperses satisfactory clay debris and lowers soil electricity in the puddle layer. In rice - rice systems, soil often goes to moist and dry situations encourages lack of N by means of leaching and denitrification. in addition, considering that nitrite is an intermediate in both the reduction of nitrate may be extra extensive and large than previously found out especially on soils the ones is alternately moist and dry. Moreover, rice-rice cropping system also required large amount of irrigation water that is an alarming state of affairs inside the place. However, crop diversification with economically possible crops appears to be suitable option within the region. The sort of series of crops grown on a land location over a period of time is known as 'cropping system'.

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In India, rice-based cropping device has been recognized as an effective approach for attaining the objectives of food security, vitamins security, poverty relief, employment technology, income increase, sensible use of land and water resources, sustainable agricultural improvement and environmental development (Singh, 2001) ^[14]. Rice - primarily based cropping device becomes very important for improving the productiveness, producing extra earnings, employment and situation of the small and marginal farmer because of inadequate operational resources. Rice need to be farming economically viable and ecologically sustainable because of upward push in input costs, speedy degradation of rice ecologies due to imbalance use of fertilizers and injudicious water management, high competition in global marketplace for rice and troubles of coping with buffer meals grain inventory in India. Therefore, intensification along with higher use of resources for remunerative vegetation in rice ecology through system perspective is vital.

Development of green cropping structures, amendment of crop micro-environment and different help offerings are critical adaptation strategies to decrease the impact of natural risks on crop boom, stabilize the crop production and farm earnings. Cropping machine in an area are decided in most cases by the types of soil and climatic parameters which determine usual agro-ecological putting for nourishment and appropriateness of a crop or set of crops for cultivation. capability productivity and financial benefit acts as a guiding principle for opting particular plants or cropping gadget.

Crop sequencing may intensify synergistic interactions among plants (Tanaka *et al.*, 2005) ^[16]. The significance of extraordinarily in depth crop series is well identified to fulfill the growing call for of ever-growing populace. An in depth cropping that isn't entirely extremely effective and worthwhile but conjointly strong over the of your of time and conjointly continues soil fertility is of maximum importance in nowadays situations. An intensification of cropping sequences is vital depending on the requirement of the arena. Oilseeds and pulses as well as veggies receiving additional interest as a result of better fees to augmented demand. Inclusion of those crops in a completely sequence changes the economics of the cropping sequences (Tomar and Tiwari, 1990) ^[17].

Rice (*Oryza sativa* L.) is principal crop grown extensively during the rainy season. Wheat (*Triticum aestivum* L.), chickpea (*Cicer arietinum*), garden pea (*Pisum sativum* L.), onion (*Allium cepa* L.), garlic (*Allium sativum* L.) and potato (*Solanum tuberosum* L.) are the major Rabi crops grown under irrigated conditions. Economic viability and their sustainable under rice based cropping system need to be investigated in cropping system mode adapting with high yielding varieties of crops. In Chhattisgarh, land remains fallow in Zaid season after harvesting of winter crops despite availability of water for irrigation. Short duration crops like i.e. cowpea (*Vigna unguiculata* (L.) Walp.), greengram (*Vigna radiata* L.), sesame (*Sesamum indicum*), okra (*Abelmoschus esculentus*) and blackgram (*Vigna mungo*) may be introduced in rice based cropping system in summer for maximum system productivity, net return, harvesting higher solar energy and restoring soil fertility. Therefore, it is important to identify suitable rice-based crop sequences under irrigated conditions to enhance the total productivity, profitability and cropping intensity of the Chhattisgarh state. Crop intensification and diversification might have helped to generate employment avenues in agriculture sector along with processing industries.

Materials and Methods

A field experiment on diversification of rice based cropping system for enhancing productivity, resource use efficiency and economics under irrigated condition was conducted at Research cum Instructional Farm, Pt. Shiv Kumar Shastri College of Agriculture and Research Station, Rajnandgaon for the consecutive two years during all the three seasons of 2018-19 and 2019-20. The experimental plot was typical medium and which some time get submerged in rainy season and is suitable for rice in kharif and also to the Rabi and Zaid crops. The experimental plots had fairly uniform topography with homogenous fertility and soil characteristic typical to suit medium land crop cultivation. The experiment was laid out in randomized complete block design with three replication in the same location through the study period. Treatment comprised of the rice based cropping system, namely T₁- rice - rice, T₂ - rice - chickpea - fallow, T₃ - rice - wheat - greengram, T₄ - rice - sweet corn + cowpea (1:1) - cluster bean, T₅ - rice - chickpea (veg.) - sesame, T₆ - rice - garlic - cowpea, T₇ - rice - coriander (leaf) - sweet potato, T₈ - rice -pea - okra, T₉ - rice - onion + Coriander (leaf) (3:1) - greengram and T₁₀ - rice - potato - blackgram. All the crops were grown with the recommended package of practices the under irrigated conditions of Chhattisgarh. The cost of cultivation and production for all the crops were worked out on the basis of the prevailing input and market price of the produce and yield of different component crops in a system were converted into gross return in rupees based on current market price. The Energy input and output was calculated from sowing to harvest of all the crops. Energetic were calculated in Mega joule (MJ) ha⁻¹ with reference to the standard value (Mittal *et al.*, 1985) ^[4]. Standard values, which are taken from energy estimation are given in the Appendix-1

Results and Discussion

System rice equivalent yield (SREY)

Rice grain yield in kharif, rice equal yield (REY) of vegetation in Rabi and REY of vegetation in Zaid season clever introduced to compute SREY of different cropping structures. The system rice equivalent yield (SREY) (t ha⁻¹) of systems in diverse crop sequences differed appreciably at some stage in each the years and on the premise of imply information. It is glaring from the facts offered in table 1 that in standard, sequences with 300% intensity produced appreciably higher device rice equal yield (SREY) than rice - rice (T₁) observed through rice - chickpea - fallow (T₂) sequence having 200% intensity. The various cropping sequences, rice - coriander (leaf) - sweet potato (T₇) produced drastically better SREY than relaxation of other structures throughout 2018-19. But, rice - potato - blackgram (T₁₀) proved notably advanced to other cropping sequences in the second yr. and on imply foundation with appreciate to SREY. While, lowest general productivity was noted in rice - rice (T₁) cropping machine all through each the year and on suggest basis. Further, rice - potato - blackgram (T₁₀) cropping machine was at par with rice - coriander (leaf) - sweet potato (T₇) cropping gadget on suggest foundation. This might be due to better productiveness as well as proper market fee of potato in addition to good grain yield and better market price of greengram that proved substantially better for attaining higher SREY through this sequence. This result is conformance with the effects of earlier employees Sharma *et al.* 2010, Saha *et al.* 2012, Singh *et al.* 2013 ^[11, 8, 15].

Table 1: Effect of different rice based cropping systems on system rice equivalent yield (SREY)

Treatment	SREY (t ha ⁻¹)		
	2018-19	2019-20	Mean
T ₁ : Rice - Rice - Fallow	9.05	8.66	8.86
T ₂ : Rice - Chickpea - Fallow	9.49	9.19	9.34
T ₃ : Rice - Wheat - Greengram	12.50	12.92	12.71
T ₄ : Rice - Sweet corn+ Cow pea (1:1) - Clusterbean	22.17	22.07	22.12
T ₅ : Rice - Chickpea (veg.) - Sesamum	13.93	14.03	13.98
T ₆ : Rice - Garlic - Cowpea	17.60	23.44	20.52
T ₇ : Rice - Coriander (leaf) - Sweet potato	22.90	22.62	22.76
T ₈ : Rice - Pea - Okra	17.45	16.94	17.19
T ₉ : Rice - Onion + Coriander (leaf) (3:1)- Greengram	17.74	19.24	18.49
T ₁₀ : Rice - Potato - Blackgram	21.69	24.28	22.98
SEm(+)	0.22	0.20	0.20
CD (P=0.05)	0.66	0.58	0.60

Farm gate price / MSP of crops (₹.q⁻¹)

Year 2018-19: Rice 1750/-, Chickpea 4620/-, Wheat- 1870/-, Sweet corn 1500/-, Cowpea 1200/-, Garlic 5000/-, Coriander (leaf) 1000/-, Pea 1800/-, Chickpea (veg.) 800/-, Onion 1200/-, Potato 1000/-, Summer paddy 1470/-, Coriander (leaf) 900/-, Green gram 6975/-, Cluster bean 2300/-, Sesamum 6249/-, Cowpea (summer) 1300/-, Sweet potato 1200/-, Okra 1200/-, Black gram 5600/-.

Year 2019-20: Rice 1815/-, Chickpea 4875/-, Wheat- 1925/-, Sweet corn 1500/- Cowpea 1200/-, Garlic 8000/-, Coriander (leaf) 1000/-, Pea 1800/-, Chickpea (veg.) 800/-, Onion 1400/-, Potato 1200/-, Summer paddy 1470/-, Coriander (leaf) 900/-, Green gram 7050/-, Cluster bean 2300/-, Sesamum 6485/-, Cowpea (summer) 1300/-, Sweet potato 1200/-, Okra 1200/-, Black gram 5700/-

Fee of cultivation of device (Ha⁻¹)

The data relating cost of cultivation of various cropping sequences are summarized in table 2. It's far clean from the facts that inclusion of third crop in rice - rice sequence throughout Zaid season either as greengram, blackgram, candy potato, cowpea, clusterbean and other plants markedly enhanced the value of cultivation. Among all of the cropping gadget, rice - coriander (leaf) - sweet potato (T₇) concerned highest price of production which was observed markedly higher than different machine. The lowest value of cultivation turned into recorded in rice - chickpea - fallow (T₂) gadget. Most of the specific cropping gadget lowest fee of cultivation became mentioned with rice - chickpea (veg.) - sesamum (T₅) gadget which having 300% depth. This suggests that the inclusion of vegetable at some stage in iciness season enhanced the cost of production.

The higher cost of cultivation of vegetable cropping machine might be attributed to the greater number of labours required for the cultivation. Despite the fact that, lowest cost of cultivation became recorded by means of rice - chickpea - fallow (T₂) device thanks to simplest two plants in machine. Further, Kumar *et al.* (2008) [18] working on one of a kind rice based totally cropping device said that rice (medium duration) - potato - greengram crop collection incurred higher value of cultivation. Sharma *et al.* (2008) [10] were also of the opinion that addition of potato and onion within the device expanded the cultivation value, as they required heavy fertilization and labour.

Gross go back of machine (Ha⁻¹)

A close exam of statistics supplied in table 2 indicated that in spite of maximum price of cultivation, rice - coriander (leaf) - candy potato (T₇) gadget gave notably better gross returns compared to different cropping machine during 2018-19. But, all through 2019-20 rice - potato - blackgram (T₁₀) received considerably maximum gross go back. These remedies had been statistically at par with rice - coriander (leaf) - candy potato (T₇) on suggest basis. It changed into attributable to higher system productivity over different cropping systems. Despite the fact that, rice - rice (T₁) gadget recorded considerably lowest gross return for the duration of both the years and on imply foundation of test due to lower in machine productiveness.

Internet go back of system (ha⁻¹)

A critical evaluation of facts presented in desk 2 discovered that rice - sweetcorn + cowpea (1:1) - clusterbean (T₄) cropping gadget registered considerably maximum net go back over rest of the cropping systems all through 2018-19 and on imply basis. However, rice - garlic - cowpea (T₆) cropping system acquired most net return for the duration of 2019-20. Rice - potato - blackgram (T₁₀) became the next with a purpose to highest net go back. While, the lowest net go back (ha⁻¹) become recorded in rice - rice (T₁) cropping system all through both the years and on mean foundation. The very best net go back device become recorded in rice - candy corn + cowpea (1:1) - clusterbean (T₄) because of higher price of the produces and proved to be the maximum remunerative cropping structures. Singh *et al.* (1997) [13] suggested that multiple cropping systems with legumes gives unique benefit to farmer. Comparable end result has also been mentioned by using Saroch *et al.* (2005) [9].

Benefit: cost ratio of system

Advantage: Fee ratio of machine Perusal of data provided in table 2 found out that diversification of rice - rice device markedly prompted the device B:C ratio at some point of each the years of research. Considerably better B: C ratio became mentioned under rice - chickpea (veg.) - sesamum (T₅) compared to different cropping gadget throughout both the years and on imply foundation. Rice - candy corn + cowpea (1:1) - clusterbean (T₄) ranked second additionally proved distinct superiority over relaxation of the cropping machine at some point of each the years of take a look at. This could be attributed to proper performance of vegetation and relatively decrease price of cultivation compared to different cropping covered. though, the bottom B: C ratio recorded rice- garlic-cowpea (T₆) for the duration of 2018-19 and rice - rice (T₁) cropping machine in year 2019-20 but, in case of mean foundation the rice-coriander (leaf)-candy potato (T₇) show the bottom B: C ratio of test. This could because of negative overall performance of rice - rice cropping gadget and higher enter value of planting cloth of sweet potato. comparable result became also stated by means of earlier workers Prasad *et al.* 2012 and Baishya *et al.* 2016 [6, 2].

Table 2: Effect of different rice based cropping system on system economics

Treatment	Cost of cultivation (₹ ha ⁻¹)			Gross return (₹ ha ⁻¹)			Net return (₹ ha ⁻¹)			B:C ratio		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T ₁ : Rice - Rice - Fallow	59905	68638	64272	158357	157217	157787	98452	88579	93515	2.64	2.29	2.47
T ₂ : Rice - Chickpea - Fallow	47855	55610	51733	166127	166753	166440	118272	111143	114707	3.47	3.00	3.24
T ₃ : Rice - Wheat - Greengram	75741	84018	79880	218757	234583	226670	143016	150565	146791	2.89	2.79	2.84
T ₄ : Rice - Sweet corn + Cow pea (1:1) - Clusterbean	112677	126034	119356	388018	400503	394261	275341	274469	274905	3.44	3.18	3.31
T ₅ : Rice - Chickpea (veg.) - Sesamum	66402	76052	71227	243834	254584	249209	177432	178532	177982	3.67	3.35	3.51
T ₆ : Rice - Garlic - Cowpea	135504	136225	135865	308047	425367	366707	172543	289142	230843	2.27	3.12	2.70
T ₇ : Rice - Coriander (leaf) - Sweet potato	161165	177303	169234	400706	410631	405669	239541	233328	236435	2.49	2.32	2.40
T ₈ : Rice - Pea - Okra	113679	127778	120729	305369	307427	306398	191690	179649	185669	2.69	2.41	2.55
T ₉ : Rice - Onion + Coriander (leaf) (3:1) - Greengram	115730	130476	123103	310485	349163	329824	194755	218687	206721	2.68	2.68	2.68
T ₁₀ : Rice - Potato - Blackgram	158079	172157	165118	379603	440634	410118	221524	268477	245000	2.40	2.56	2.48
SEm±	-	-	-	3876	4147	3837	3876	4147	3837	0.04	0.04	0.04
CD(P=0.05)	-	-	-	11516	12322	11401	11516	12322	11401	0.11	0.12	0.10

Machine electricity input (103 × MJ ha⁻¹)

Records on strength enter of various cropping sequences are offered in table 3. The maximum strength input turned into recorded in rice - potato -blackgram device (T₁₀) the various special cropping sequences. This can be higher want of strength enter was manifested in better strength required over seed and fertilizers in growing a potato crop. But, the lowest strength enter changed into incurred in rice - chickpea - fallow (T₂) cropping series. similarly, Kachroo *et al.* (2012) operating on unique rice-based cropping sequences additionally said as rice-potato-maize + green gram required highest power input accompanied through rice-potato-onion series. This result is settlement with the locating of Gangwar and Katyal (2001) [3] as they observed that rice - potato - sesame harvested maximum strength.

System power output (103 × MJ ha⁻¹)

A crucial analysis of facts presented in table three revealed that, in well known, energy output became better in 2nd 12 months of experiment in comparison to first year in maximum of the cropping sequences. most of the distinctive cropping sequences, rice -candy corn + cowpea (1:1) - clusterbean (T₄) recorded drastically better energy output at some point of each the years and on suggest foundation of test. This can be attributed to better yield of sweetcorn + cowpea

(1:1) in affiliation with appropriate yield and energy equal of other factor plants in these structures. Nonetheless, lowest energy output was recorded in rice - chickpea - fallow (T₂) all through each years and on suggest foundation of test may be attributed to decrease strength equal of each rice and chickpea. Bohra *et al.* (2007) [19] opinion that cropping sequences with high productive plants and higher depth brought about more machine output strength. Similar, result additionally received by using Sharma *et al.* (2008) [10].

Gadget power output: input ratio

Facts on power output: enter ratio supplied in table 3 discovered that distinctive rice based cropping sequences markedly prompted on electricity output: enter ratio at some stage in each the years of look at. Rice - sweet corn + cowpea (1:1) - clusterbean (T₄) recorded drastically higher electricity output: enter ratio for the duration of both the years and on imply foundation of test. This will be attributed to its higher electricity return in comparison to different device. however, lowest energy output was recorded in rice - garlic - cowpea (T₆) for the duration of both years and on imply foundation of test the lowest power output: enter ratio because of owing to the consumption of higher power enter in comparison to different cropping sequences. Similar result has also been stated with the aid of Singh *et al.* (2017) [12].

Table 3: Effect of different rice based cropping systems on energy input, energy output and energy output: input ration

Treatment	System energy input (MJ ha ⁻¹ ×10 ³)			System energy output (MJ ha ⁻¹ ×10 ³)			System energy output: input		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T ₁ : Rice - Rice - Fallow	29.27	29.27	29.27	145.00	141.09	143.04	4.95	4.82	4.89
T ₂ : Rice - Chickpea - Fallow	19.60	19.60	19.60	96.32	94.88	95.60	4.91	4.84	4.88
T ₃ : Rice - Wheat - Greengram	34.89	34.89	34.89	135.77	140.31	138.04	3.89	4.02	3.96
T ₄ : Rice - Sweet corn + Cowpea (1:1) - Clusterbean	35.12	35.12	35.12	298.32	310.22	304.27	8.49	8.83	8.66
T ₅ : Rice - Chickpea (veg.) - Sesamum	30.83	30.83	30.83	144.35	146.80	145.57	4.68	4.76	4.72
T ₆ : Rice - Garlic - Cowpea	33.57	33.57	33.57	80.74	80.28	80.51	2.41	2.39	2.40
T ₇ : Rice - Coriander (leaf) - Sweet potato	34.36	34.36	34.36	146.59	148.62	147.60	4.27	4.33	4.30
T ₈ : Rice - Pea - Okra	36.04	36.04	36.04	108.39	105.42	106.91	3.01	2.93	2.97
T ₉ : Rice - Onion+ Coriander (leaf) (3:1) - Greengram	37.86	37.86	37.86	106.70	108.57	107.64	2.82	2.87	2.84
T ₁₀ : Rice - Potato - Blackgram	50.56	50.56	50.56	219.47	224.18	221.83	4.34	4.43	4.39
SEm(+)	-	-	-	2.06	2.03	1.91	0.06	0.06	0.06
CD (P=0.05)	-	-	-	6.12	6.02	5.68	0.18	0.18	0.16

System electricity use efficiency (kg MJ ha⁻¹)

Information referring to strength use efficiency of different cropping sequences offered in table four truly indicated that significantly higher electricity use performance turned into noted below rice - coriander (leaf) - candy potato (T₇) cropping machine. In comparison to relaxation of the cropping sequences all through each the years and suggest basis of experimentation.

This become on the whole because of the better yield of candy potato at the side of contribution of coriander (leaf) in overall productivity of the sequence. However, the lowest energy use performance became recorded in rice - rice (T₁) machine in the course of both the years and mean foundation might be assigned to terrible overall performance of rice - rice cropping device in addition to better strength ate up. The outcomes are in

conformity with Singh *et al.* (2017) ^[12], who stated maximum energy-use performance ratio (5.25) with the rice-lentil-maize (fodder) system at Nainital. The end result is likewise in line with Patra *et al.* (2017) ^[5].

Machine energy depth (MJ⁻¹)

Information touching on electricity intensity are offered in table 4. A close examination of the data discovered that rice - sweetcorn + cowpea (1:1) - clusterbean (T₄) recorded appreciably better energy depth than rest of the cropping gadget throughout each the years and on suggest foundation of

experiment. However, the bottom energy intensity turned into recorded in rice - garlic - cowpea (T₆) system in the course of both the years and suggest basis of experiment. This become specifically due to its better strength go back in contrast to investing value.

The higher power depth of rice - sweetcorn + cowpea (1:1) - clusterbean (T₄) system is probably because of their lesser cost of production in assessment to different machine. The outcomes are in conformity with Bastia *et al.* (2008), who mentioned substantially highest electricity intensity in rice-maize-cowpea cropping series over 9 different rice based cropping sequences.

Table 4: Effect of different rice based cropping systems on energy use efficiency and energy intensity

Treatment	System energy use efficiency (Kg MJ ha ⁻¹)			System energy intensity (MJ ₹ ⁻¹)		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T ₁ : Rice - Rice - Fallow	0.31	0.30	0.30	2.42	2.06	2.24
T ₂ : Rice - Chickpea - Fallow	0.48	0.47	0.48	2.07	1.76	1.91
T ₃ : Rice - Wheat - Greengram	0.36	0.37	0.36	1.79	1.67	1.73
T ₄ : Rice - Sweet corn + Cowpea (1:1) - Clusterbean	0.63	0.63	0.63	2.65	2.46	2.55
T ₅ : Rice - Chickpea (veg.) - Sesamum	0.45	0.45	0.45	2.17	1.93	2.05
T ₆ : Rice - Garlic - Cowpea	0.52	0.70	0.61	0.60	0.59	0.59
T ₇ : Rice - Coriander (leaf) - Sweet potato	0.67	0.66	0.66	0.91	0.84	0.87
T ₈ : Rice - Pea - Okra	0.48	0.47	0.48	0.95	0.83	0.89
T ₉ : Rice - Onion+ Coriander (leaf) (3:1) - Greengram	0.47	0.51	0.49	0.92	0.83	0.88
T ₁₀ : Rice - Potato - Blackgram	0.43	0.48	0.45	1.39	1.30	1.35
SEm(+)	0.01	0.01	0.01	0.02	0.02	0.02
CD (P=0.05)	0.02	0.02	0.02	0.06	0.05	0.05

Conclusion

Rice - potato - blackgram (22.ninety eight t ha⁻¹) device rice equal yield (SREY) found to be most appropriate cropping gadget with appreciate to productiveness for inceptisols below irrigated condition. The most gross return (4,10,118.00 ha⁻¹) and energy input (50.56 MJ ha⁻¹ × 103) became obtained beneath rice - potato - blackgram but internet return (2,74,905 ha⁻¹), energy output (304.27 MJ ha⁻¹ × 103), energy output: input ratio (eight.66) and power intensity were highest under rice - candy corn + cowpea (1:1) - clusterbean whereas the rice - coriander (leaf) - sweet potato recorded extensively highest energy use performance (zero.sixty six). Rice - chickpea (veg.) - sesamum cropping machine proved to be first-class with appreciate to B: C ratio (3.51) for inceptisols beneath irrigated situation.

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Appendix- 1: Standards energy values of different input and output used during the course of investigation (Mittal *et al.*, 1985)

S. No.	Particulars		Units	Energy coefficient MJ
Input				
1.	Labour	(Adult man)	Man hr ⁻¹	1.96
		(Adult women)	Women hr ⁻¹	1.57
2.	Diesel		Liter ⁻¹	56.31
3.	Electricity		KWH	11.39
4.	Water		m ⁻³	0.63
5.	FYM		Kg ⁻¹	0.30
6.	Tractor		Kg ⁻¹	180
7.	Sprayer		Kg ⁻¹	129
8.	Chemical Fertilizer	Nitrogen	Kg ⁻¹	60.60
		Phosphate (P2O5)	Kg ⁻¹	11.1
		Potash (K2O)	Kg ⁻¹	6.7
		Microelements	Kg ⁻¹	120
9.	Pesticide	Herbicide	litre ⁻¹	238
		Fungicide	Kg ⁻¹	92
		Insecticide	litre ⁻¹	199
10.	Seed	Rice, wheat, sweetcorn, greengram, blackgram, cowpea and chickpea	Kg ⁻¹	14.7
		Potato	Kg ⁻¹	6.8
		Coriander	Kg ⁻¹	0.8
		Onion	Kg ⁻¹	1.6
		Okra	Kg ⁻¹	0.80
		Sesamum	Kg ⁻¹	25
		Sweet potato	Kg ⁻¹	3.59
11.	Economic produce	Rice, wheat, greengram, blackgram and chickpea	Kg ⁻¹	14.7
		Sweet corn	Kg ⁻¹	16.36
		Potato	Kg ⁻¹	5.6
		Coriander, okra, clusterbean, cowpea and okra	Kg ⁻¹	1.2
		Onion and garlic	Kg ⁻¹	1.6
		Sesamum	Kg ⁻¹	25
		Sweetpotato	Kg ⁻¹	3.59
		Pea and chickpea (veg.)	Kg ⁻¹	3.19
12.	Straw/ stover		Kg ⁻¹	12.50