THE ECONOMICS OF A TRADITIONAL MIXED CROPPING SYSTEM

- A Case Study of Navadhanya Cropping System of Rayalaseema Region

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ABSTRACT

Navadhanya (Narayanaswamy, 2000) is a traditional mixed cropping system predominantly practiced by the rainfed farmers of Rayalaseema region in the Southern Indian state of Andhra Pradesh (AP). Crop diversity remains the fundamental characteristic of such cropping systems & the arrangement of crops is such that it keeps the soil covered for most part of the year, a minimum of two or more standing crops always remain in the field. However, scientific studies on the different facets of Navadhanya remain meagre. A study was conducted at four villages of Ayyavaripalli of Chittoor district and Diguvapalli, Gunduvaripalli, and Paravarnapalli of Ananthapuram district of AP to analyse the economics of Navadhanya cropping system cultivated under rainfed conditions. It was found that per acre net returns from the composite yield of different crops of Navadhanya is relatively higher than the net returns of mono-cropping of peanuts in the study area. Further, it was assumed that farmers with small-size landholdings could benefit from the composite yield of different crops cultivated under such a mixed cropping system.

Keywords: Navadhanya, Mixed cropping, Traditional cropping, Poly cropping, Peanut, Ananthapuram, Chittoor, Resilience, Small-size farms, Small-farmers.

1. Introduction

Navadhanya is a traditional mixed cropping system predominantly practiced by the rainfed farmers of Rayalaseema region, which includes the four districts of Anantapuram, Chittoor, Kadapa and Kurnool, in the Southern Indian state of Andhra Pradesh (AP). Perhaps, such cropping system may have evolved over time to effectively use the primary showers of the Northeast monsoon and capture moisture from the winter dew for survival of the crops. Given that most part of the Rayalaseema region is geographically located in a dry and rain shadowed region, conservation of soil moisture is of a paramount importance for agriculture in the region. The Navadhanya cropping pattern is designed to suite the bimodal precipitation seasonality (Knoben, *et al* 2018), withstand the "Aw" or "As" (tropical wet and dry or savanna climate) conditions, (Peel, *et al* 2007; Kottek, *et al* 2006), keep the land covered for up to 9 – 10 months (from the month of June – March), and leave the ground less exposed, only for two months between the month of April and May. Navadhanya cropping system follows a meticulous planning and judicious method of sowing, tending and harvesting of multiple crops in the same plot. It involves a single sowing but yields multiple harvests and also produces reasonable amount of fodder for livestock.

Crop diversity is the fundamental characteristic of a traditional mixed cropping system like Navadhanya. Diversity of crops in such cropping systems include multiple cereals - finger millet (*Eleusine coracana*), foxtail millet (*Setaria italic*), pearl millet (*Pennisetum glaucum*), brown top millet (*Urochloa ramosa*), little millet (*Panicum sumatrense*), sorghum (*Sorghum bicolor*), maize *corn*, etc.), pulses (pigeonpea (*Cajanus cajan*), green gram (*Vigna radiata*), etc.), oil seeds (peanut (*Arachis hypogaea*), castor (*Ricinus communis*), niger (*Guizotia abyssinica*), safflower (*Carthamus tinctorius*), sunflower (*Helianthus*), mustard (*Brassica*), sesame (*Sesamum indicum*), etc.), a range of vegetables, roots, tubers, rhizomes, leafy greens, spices like turmeric (*Curcuma longa*) and even fibres like cotton (*Gossypium*), and roselle (*Hibiscus sabdariffa*), for household consumption as well as sale. Depending on the primary and secondary crops the design and crop pattern may vary - intercropping, mixed cropping, strip cropping, etc., however, crop diversity remains the fundamental characteristic of such cropping systems (Lin, 2011). The arrangement of crops is such that it keeps the soil covered for most part of the year, a minimum of two or more standing crops always remain in the field.

Although, Navadhanya cropping system is an established traditional practice in places like Rayalaseema, but scientific studies on the different facets of Navadhanya remain meagre. In this context a study was commissioned by the Watershed Support Services and Activities Network (WASSAN)★, Hyderabad, in the year 2020 to study the economics of the traditional Navadhanya cropping system practiced by small-scale farmers, under rainfed conditions in Ananthapuram and Chittoor districts of Rayalaseema region of AP. The study covers the economics of Navadhanya cropping system of Kharif season of the year 2020 in the study area.

2. MATERIALS AND METHODS

2.1. The Study Area: Ananthapuram district is geographically located at 14.6824° N, 77.6017° E, and it is the only arid region of the Indian state of Andhra Pradesh. The district is spread in an area of 19,130 km², with a total population of 4.8 million. The annual rainfall of the district is about 536 mm, as it is geographically located in the rain shadow region of the country and suffers from frequent and recurring droughts of varying intensity. Over a period of 94 years (1911 – 2004), the district experienced 51 years with below average rainfall and 18 drought years, a testimony of vulnerability of this region. The district has experienced prolonged drought of about six years, in the month of October 2018, the state government declared all 63 mandals of Anantapuram district as drought hit. An estimated 0.7 million farmer households of the district have been severely hit from the drought.

★ For more details, visit www.wassan.org

Over 89 percent of the agriculture land of the district is rainfed and only 11 percent is irrigated, making it highly susceptible to fluctuations in rainfall and vagaries of climate change. Groundnut (peanut) is the major crop of the district but that was not the case earlier. Traditionally, dry land crops of castor, different crops of millets and pulses were cultivated under multi-cropping systems in Ananthapuram. Three decades ago, more than 30 percent of the total cultivated area of the district was covered under afore mentioned crops. However, things started tilting towards cultivation of groundnut under mono-cropping system since 1990s. The area under groundnut has increased from 21.38 percent in 1955-56 to over 75 percent in 2006 and the area under multi-cropping of dry land crops shrunk to less than 10 percent now. The tectonic shift from poly-crop system to mono-crop system had been having serious implications to agro-biodiversity, and economic and food security of the small-marginal farmers.

Chittoor district is geographically located at 13.4788° N, 78.8383° E, and has an area of 15,151 km^2. It is bound by Anantapuram and Kadapa district of Andhra Pradesh on the North, Nellore district of Andhra Pradesh on the East & Chengalpattu district of Tamil Nadu on the South and North Arcot district of Karnataka on the west. It has a population of 4.4 million and 63% of the population is rural. Chittoor has a similar climate like Ananthapuram, which is a tropical wet and dry or savanna climate. The average annual temperature of the district is 26.5°C and the average annual rainfall is 934 mm. About 70% of agriculture is rainfed and 30% is irrigated. The major crop of the district is peanut (Kumar and Subramanyachary, 2015).

A total of four villages of Ayyavaripalli of Chittoor district and Diguvapalli, Gunduvaripalli, and Paravarnapalli of Ananthapuram district of Andhra Pradesh were randomly selected for the purpose of the present study.

2.2. Sample Selection: In an effort to revive the dying Navadhanya cropping system, WASSAN has piloted it Ananthapuram district of Andhra Pradesh in the year 2016 and extended it to Chittoor district in the following year 2017. The pilot covers about 380 small-scale rainfed farmers, across 40 villages, covering an area of 400 acres. A total of 38 small-size rainfed farmers (10 % sample) out of the 380 Navadhanya project farmers were selected for the purpose of the present study. However, only 25 farmers (6.5%) participated in the present study. The present study covers an area of 32 acres (8%) of rainfed area, which is a part of the total 400 acres of area covered under Navadhanya cropping system in the study area (*table 1*).

Table 1. *Details of Rainfed Farmers, Cultivated area and the Main Crop of Navadhanya Cultivated in Rainfed Conditions in the Study Area.*

	Details of the Sample	**Details of the total area and farmers in the study area**
Total No. of Navadhanya Farmers	25	380
Total Area (in ac) Under Navadhanya	32	345
Avg. Area (in ac) Under Navadhanya	1.28	1.1
Main crop - Peanut	23	
Main Crop - Brown top millet	2	

2.3. Data Collection: Primary data pertaining to the present study was collected from the resource farmers practicing Navadhanya cropping under rainfed conditions during the Kharif season of the year 2020. On field data was collected through the Kharif cropping season, of the year 2020, starting from the land preparation till the end of harvesting from the participant farmers using a specially designed questionnaire. Data variables include: area of cultivation (in acres), main crop and supplementary crops, investment on land preparation, cost of seeds, cost of seed sowing, cost of weeding, cost of harvesting, and cost of hiring labour; and returns in terms of crop yield and household income.

2.4. Data Analysis: The data was predominantly quantitative in nature and it was organized into tables for analysis. Frequencies of the respective variables was subjected to tabular analysis and visualized in histograms and pie-charts.

3. RESULTS AND DISCUSSIONS

3.1. Area and main crop of Navadhanya in the study area

It was found that the average cultivated area under Navadhanya cropping under rainfed conditions by the participant farmers of the present study was 1.28 acres. However, the results of the present study were calculated per acre of area to make it easy for comparison with per acre productivity of other cropping systems under similar or dissimilar environmental and economic conditions.

Participant rainfed farmers were found to practice two main crops in addition to the secondary / inter crops cultivated in Navadhanya crop pattern. However, peanut (*Arachis hypogaea*) was found to be the dominant main crop cultivated by 92% of the participant farmers and only 8% were cultivating brown top millet (*Urochloa ramosa*) as the main crop (*table 1 and figure 1*). The secondary / inter crops cultivated in the same plot as the main crop in different crop patterns in a rainfed Navadhanya cropping system in the study area are sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), pigeon pea (*Cajanus cajan*), cowpea (*Vigna unguiculata*), field bean (*Vicia faba*), green bean (*Vigna radiata*) kenaf (*Hibiscus cannabinus* L.), castor (*Ricinus communis*), and fodder (different spp.).

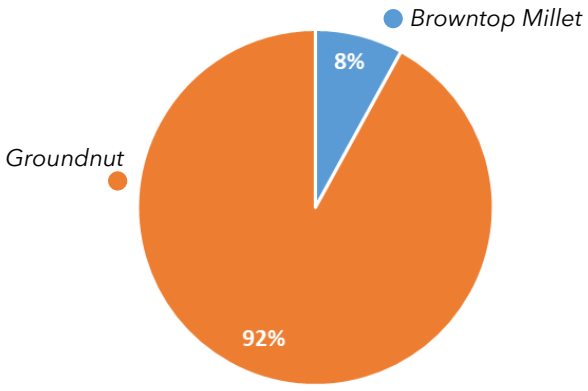


Fig. 1. *Details of Participant farmers Practicing different main crops under Navadhanya*

Logically, the area under peanut as the main crop was larger 94% and brown top millet covers only 6 % of the area under main crop (*Figure –2*). Until 1970s, over two thirds of the total cultivation area of Ananthapuram and Chittoor district was under the production of food grains, of millets, paddy and pulses (Narayanaswamy, 2016; Kumar and Subramanyachary, 2015). However, the trend has shifted towards peanut cultivation since the late 1980s and by the year 2006, over 75 percent of the total cultivation area of the district was brought under peanut cultivation (Kumar and Subramanyachary 2015; Rukmani and Manjula, 2009). The Rayalaseema region of AP accounts for 97% of the acreage of peanut in the state and half of the estimated state production (53.9%) could be attributed to Anantapuram district, which also accounts for the largest acreage (61.1%) in Andhra Pradesh (IOPEPC, 2017).

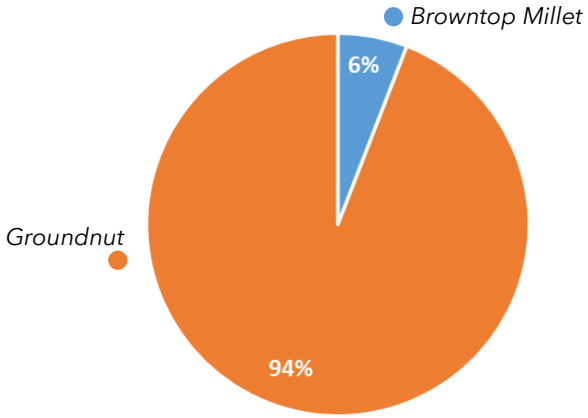


Fig. 2. *Area (in Ac) covered under different main crops in the sampled area*

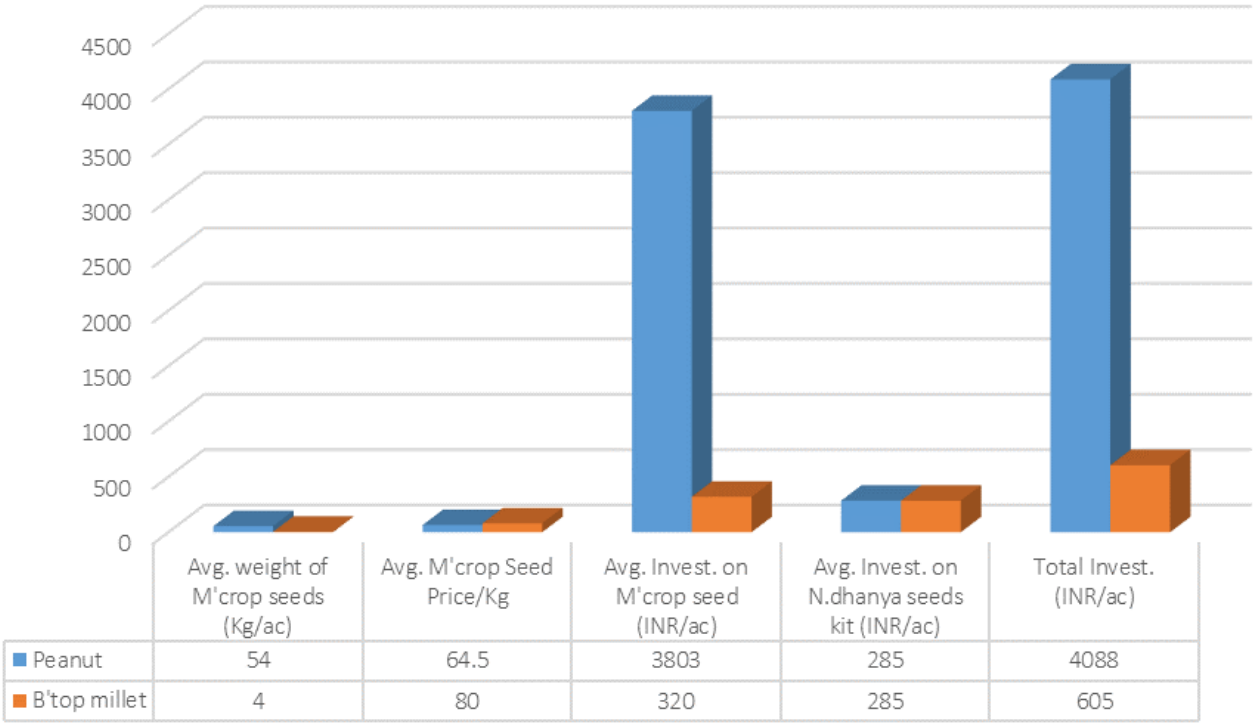
3.2. Expenditure and Investment (per acre) in Navadhanya Cropping System

[a] Investment and Requirement of Seeds (per acre) in Navadhanya Cropping System

The average weight (in kgs) of seeds of the main crop per acre in Navadhanya varies from crop to crop. The average weight of seeds of peanut was found to be 54 kgs and brown top millets was just 4 kgs. Although brown top millet (INR 80/kg) was found to be expensive than peanut (INR 64.5/kg) with regards to the price per kg of seeds but the relatively insignificant quantity of brown top millet seeds required for cultivation makes it cheaper and more affordable than peanuts. The average amount spent by the participant peanut farm-

ers on seeds was INR 3803/ac and the average amount spent by the brown top millets farmers was only INR 320/ac. In this case the participant farmers who chose peanut for the main crop spent approximately 91.58% more on seeds than farmers who preferred brown top millet for the main crop. However, the investment on Navadhanya seeds kit was found to be same (INR 285/ac) for both the peanut and brown top millet farmers. In total a farmer who chose peanut for main crop invested INR 4088/ac (85% higher) on seeds of the main crop against farmer who chose brown top millet (INR 605/ac) for the main crop (*Figure - 3*).

Naidu, et al (2019) in the study on the economics of peanut farming under mono-crop system found that the small-size, medium and large-size peanut farmers of Ananthapuram district have incurred about INR 4453.4, INR 4230.7 and INR 4170, respectively on seeds. Almost all Navadhanya practicing farmers participated in the present study are small-size and they have spent about 17% less amount on peanut seeds than their mono-crop peanut farming counter-parts.



	Avg. weight of M'crop seeds (Kg/ac)	Avg. M'crop Seed Price/Kg	Avg. Invest. on M'crop seed (INR/ac)	Avg. Invest. on N.dhanya seeds kit (INR/ac)	Total Invest. (INR/ac)
Peanut	54	64.5	3803	285	4088
B'top millet	4	80	320	285	605

Fig. 3. *Investment and Requirement of Seeds of the Main Crop (per acre) in Navadhanya*

[b] Investment for Preparation of the Land for Cultivation

It was found that the average time and cost for preparation of an acre of land at the study area was 2.9 hours and INR 2300 respectively. The main source of energy for land preparation in the study area was a tractor. The cost is usually paid for the rental or fuel for the tractor and farm machinery.

[c] Investment in Sowing Seeds of Navadhanya under different Main Crops

The average cost of seed sowing varies according to farmer's choice of source of energy in the study area. It was observed that almost all farmers (except one) who chose peanut for the main crop went for a tractor both for land preparation (96%) and seed sowing (88%). Contrarily, both the farmers who chose brown top millet for the main crop went for animal energy (oxen) for seed sowing (fig. 4). Out of the two farmers who chose animal energy for seed sowing however, opted for different sources of energy for land preparation, while one of them went for a tractor and the other chose oxen for land preparation.

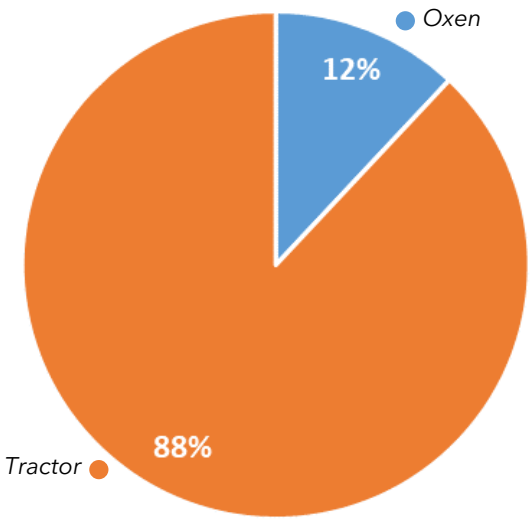


Fig. 4. *Percentage of Farmers Using Animal Energy And Tractors for Sowing Seeds*

The average cost for seed sowing of Navadhanya under peanut and brown top millet as the main crop was found to be INR 1261 and INR 280, per hr respectively. It was observed that farmers who chose peanut for the main crop spent 78% higher amount per hour than farmer who chose brown top millet for the main crop (fig. 5). Perhaps the difference in the investment in terms of money spent was due to hiring and fuel charges of tractor and farm machinery. It was noticed that the number of labour required under both the energy systems was similar (*Table - 2*).

Table 2. *Cost and Source of Energy for Sowing Seeds of Navadhanya under different Main Crops*

Source of Energy	Oxen	Tractor
No. of farmers	3 (12%)	22 (88%)
No. of labour	1	1
Average cost / hr	280	1261
Main crop	Browntop millet	Peanut

(d) Costs of Weeding Using Different Sources of Energy and Equipment

Weeding operations are carried out only once (twice in case of unusual circumstances), usually 20 – 25 days after seed sowing in Navadhanya cropping system. Three kinds of energy sources were observed in the study area. Participant farmers of the study were using manual cycle weeders, oxen and handpicking by humans for weeding. However, handpicking (92%) was found to be the most popular method of weeding than manual cycle weeder (4%) and oxen/animal energy (4%) in the study area (*Figure–6).*

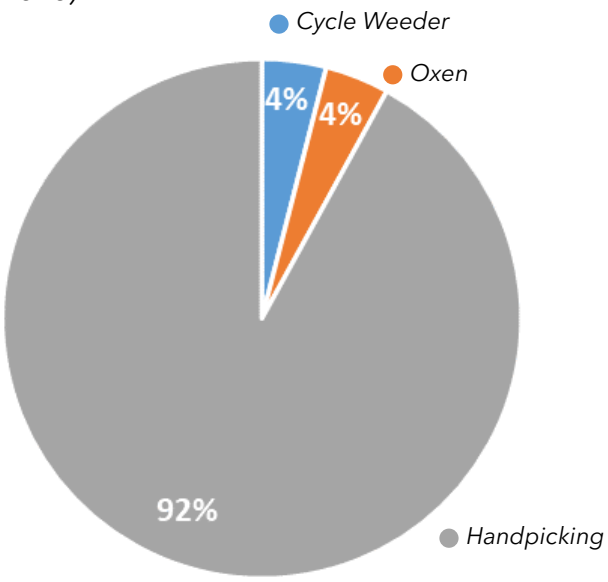
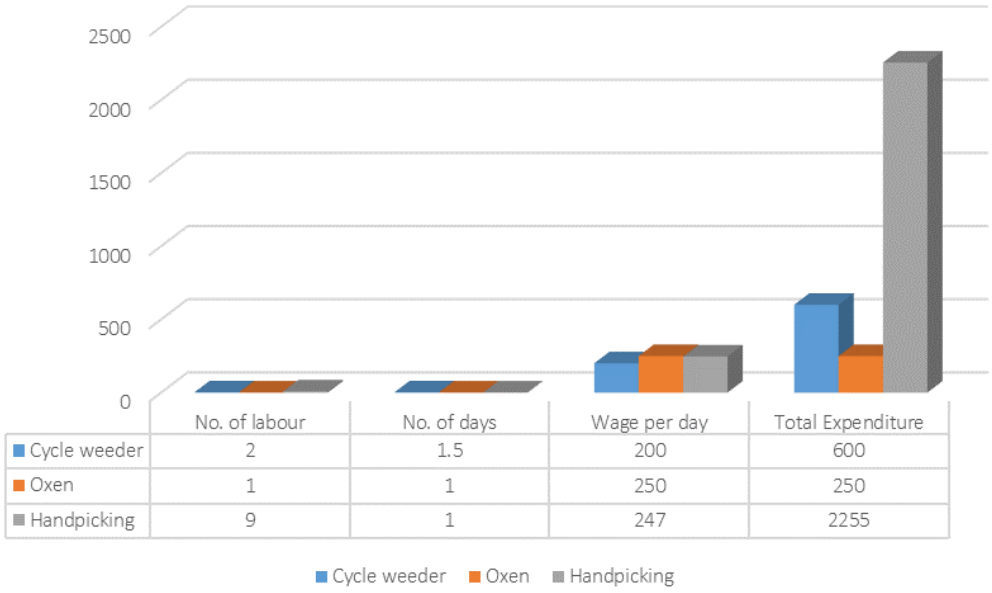


Fig. 6. *Farmers Using Animal Energy And Tractors for Sowing Seeds*

The total cost of weeding reported by the participant farmers varies according to the nature of the weeding method they follows. Participant farmers who preferred handpicking were reported to have spent INR 2255/ac/per day for weeding, farmers who preferred oxen/animal energy have spent INR 250/ac/per day and farmers who deployed manual cycle weeder have spent INR 600/ac/per day. It was observed that farmers who employed labour for handpicking spent 73% and 89% higher amount than farmers who preferred manual cycle weeder and oxen for weeding. The higher expenditure of manual handpicking method could be attributed to the

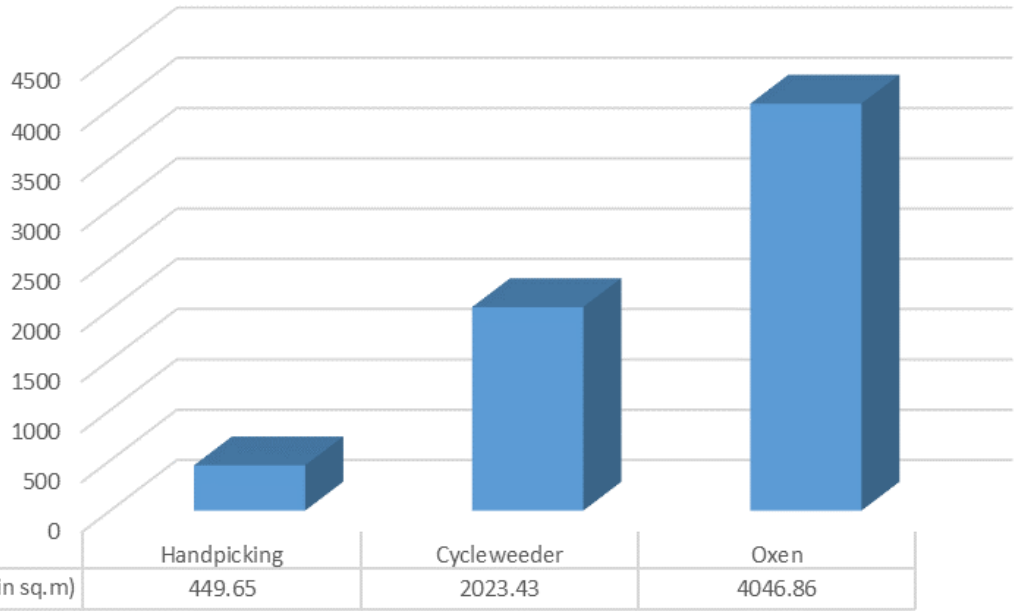
number of labour required/hired under this weeding methods. For instance, farmers who preferred manual handpicking hired about 9 labour per day/per ac, compared to farmers who deployed manual cycle weeders (2 no. of labour) and oxen/animal energy (1 no. of labour), (*Figure - 7*).



	No. of labour	No. of days	Wage per day	Total Expenditure
Cycle weeder	2	1.5	200	600
Oxen	1	1	250	250
Handpicking	9	1	247	2255

Fig. 7. *Break-up of the Total Cost of Weeding in the Study Area*

In terms of efficiency with regards to coverage of weeding area, the oxen/animal energy based method appears to be effective not only in terms of labour, cost, and coverage. Oxen/animal energy based method was observed to require 77% and 89% less labour when compared to manual cycle weeder and handpicking respectively. In terms of cost it is 89% and 58% cheaper than handpicking and manual cycle weeding respectively. The area covered by a single oxen/animal for weeding was observed to be 4046.86 sq.m per day when compared to handpicking and manual cycle weeding by each labour which was found to be 449.65 sq.m and 2023.43 sq.m respectively. Each oxen/animal covers 97% and 50% more area per day when compared to each human deployed for weeding by using handpicking and manual cycle weeder respectively (*Figure - 8).*



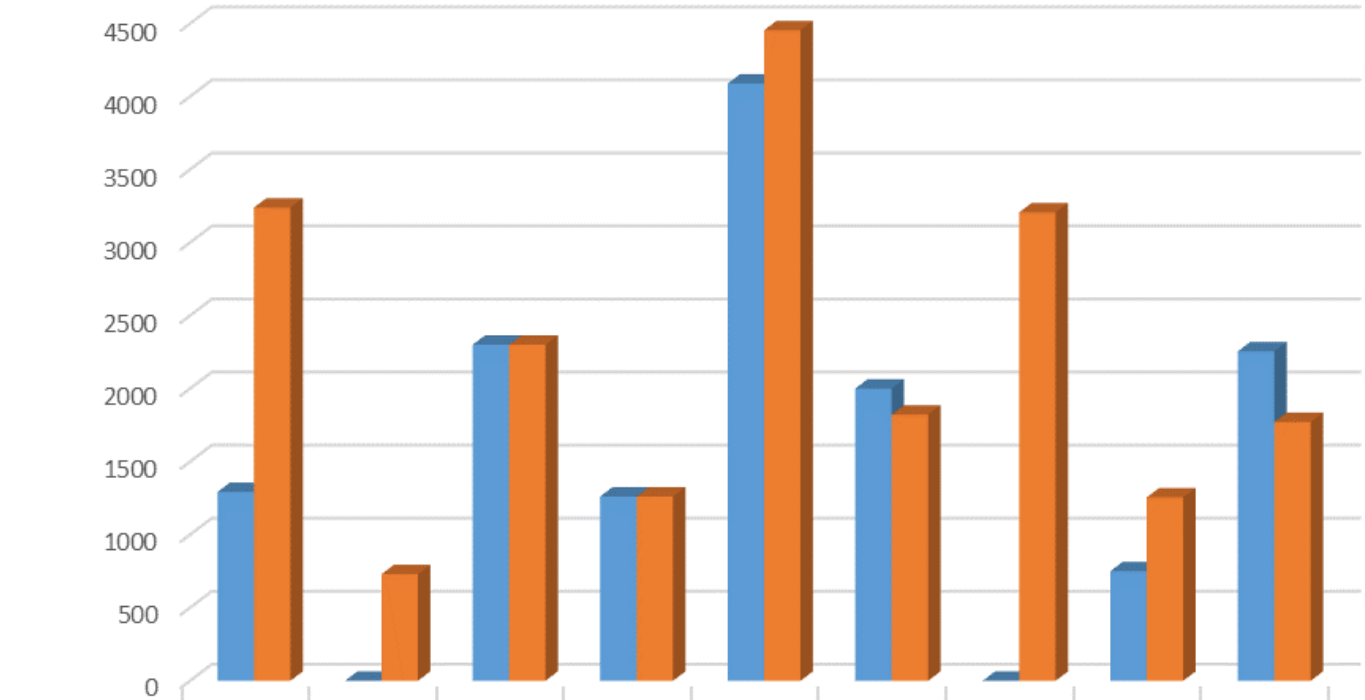
	Handpicking	Cycleweeder	Oxen
Area Covered (in sq.m)	449.65	2023.43	4046.86

Fig. 8. *Comparison of the Amount of Area Covered (in sq.m / day) Under Different Weeding Methods*

(e) Cost of Harvesting and the Total Expenditure on Navadhanya Cropping System

Harvesting in Navadhanya was done predominantly by handpicking. The average number of labour hired for harvesting is usually 5 persons per acre and the average number of days spent on each harvest is 1.3 days. The average wage for labour per head/day was reported to be INR 206.6 in the study area. The total average expenditure spent on harvesting a Navadhanya crop was reported to be INR 1291.6/ ac.

The average total cultivation cost per acre (including only the actual costs of hired labour, machinery labour charges, cost of land preparation, seed sowing, cost of seeds, cost of manure, cost of fertilizer, cost of irrigation, cost of plant protection/weeding) incurred by a farmer practicing Navadhanya under rainfed conditions (irrespective of the choice of the main crop) in the study area and the irrigated, mono-cropping peanut farmers covered under the study of Naidu, et al (2019), were INR 13946 and INR 20036, respectively. Perhaps the small-size the mono-cropping, irrigated, peanut farmers covered in the study of Naidu, et al (2019) have invested 30% more per acre than Navadhanya farmers cultivating peanuts in an equal area under rainfed conditions in the study area (*Figure - 9*).



	Hired labour (manu. harv. Nava..)	Machinery labour charges	Cost of land prep. (Trac)	Cost of seed sowing (Trac)	Cost of seed	Cost of manure	Cost of fertilizer	Cost of irrigation (critical irri. Nava.)	Cost of plant protection (manu. weeding Nava..)
Navadhanya	1292	0	2300	1261	4088	2000	0	750	2255
Monocrop	3239	729	2300	1261	4453	1822	3206	1255	1771

Fig. 9. *Per acre total cost of cultivation incurred by small-size farmers practicing rainfed Navadhanya cropping and irrigated mono-cropping of peanuts*

3.3. Output / Income (per acre) of Navadhanya Cropping System

(a) Average Yield / acre of the Different Crops of Navadhanya in the Study Area

The average yield of peanut and Brown top millet as the main crop under Navadhnaya was reported to be 500 kg/ac (1235 kg/ha) and 600 kg/ac (1482 kg/ha) respectively. The average yield of pigeon pea, sorghum, pearl millet, cowpea, castor, field bean, green bean, kenaf and fodder per acre were reported as 30 kg, 10 kg, 11 kg, 21 kg, 15 kg, 29 kg, 11 kg, 3 kg and 100 kg respectively (fig. 10). However, when the yield of all crops of Navadhanya with peanut as the main crop was put together, the yield per acre was approximately 730 kgs in the present study.

The highest yield (1,703 kg/ha (or) 689.4 kg/ac) of peanut was estimated for Kurnool district and the lowest (1,121 kg/ha (OR) 453.8 kg/ac) for Anantapuram district (IOPEPC, 2017). In another study by Rukmani and Manjula (2009) the yield of peanut in Ananthapuram during the period 2004-05 was reported at 516 kg/ha (208.9 kg/ac). Naidu, et al (2019) found that the yield of peanut (cultivated as a mono-crop) among the small-scale, medium and large-scale farmers in Ananthapuram district was 688.2 kg/ac, 708.5 kg/ac, and 712.5 kg/ac respectively. However, results of the present study suggest that the yield of peanut under Navadhanya cropping system in the study area was 10% and 139% higher than the yields reported by IOPEPC (2017) and Rukmani and Manjula (2009) respectively. On the contrary, the results of the present study suggests that the per acre yield of peanut cultivated on small-scale farms under Navadhanya cropping system is 37.6% less when compared to results of the study conducted by Naidu, et al (2019). It is important notice here that peanuts cultivated under Navadhanya system was cultivated under rainfed conditions and zero synthetic fertilizer inputs by farmers of the present study, unlike the farmers covered in the study of Naidu, et al (2019) that used irrigation and synthetic fertilizers for cultivation of peanuts under a mono-cropping system.

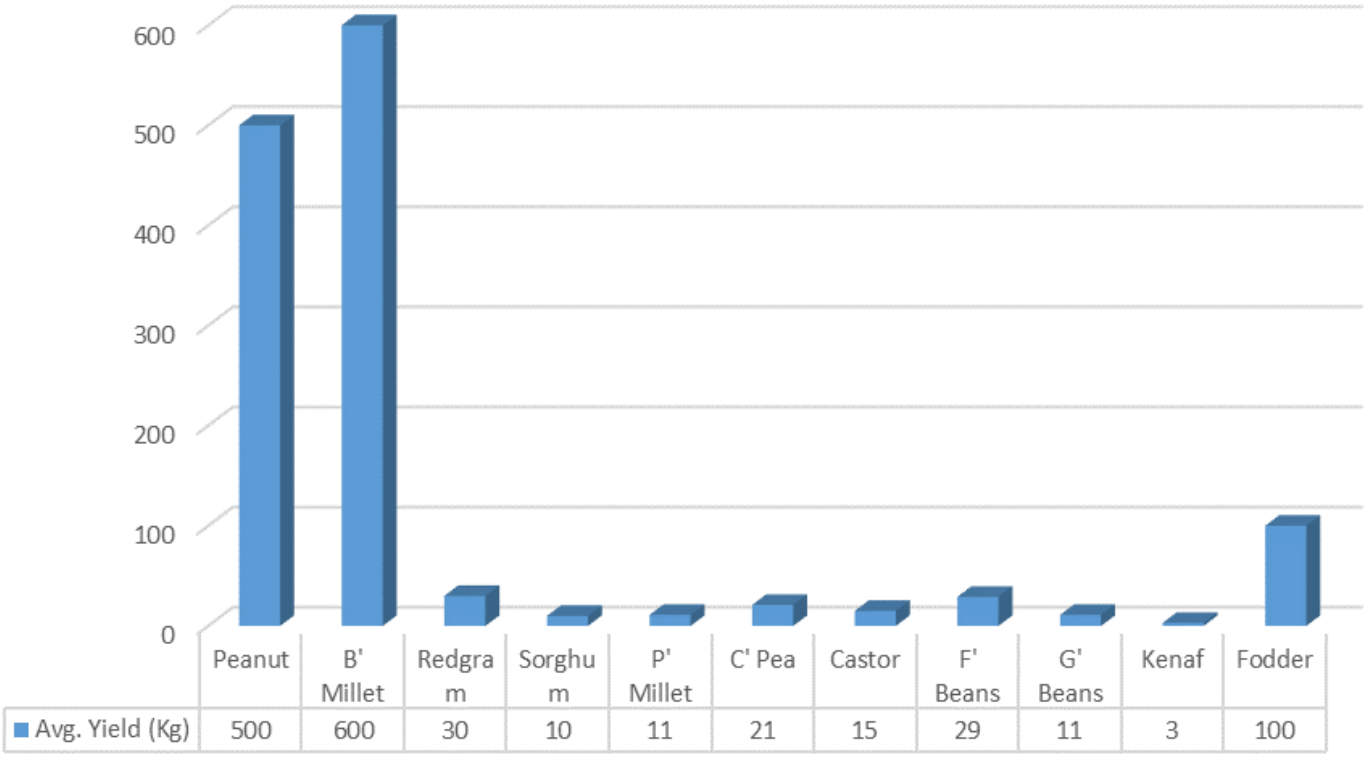


Fig. 10. *The Average Yield (Kg) / Acre of the Different Crops Cultivated in Navadhanya at the Study Area*

The yield of brown top millet is 700 – 800 kg/ac (Reddy and Govindaiah, 2021). Results of the present study suggest that the yield of brown top millet cultivated under Navadhanya cropping system is 600 kg/ac. However, further studies and a larger sample size is required to investigate the performance of brown top millet under Navadhanya cropping system. Reports suggest that the hardy and resilient brown top millet can be cultivated not only under water scarce conditions but also in low lying flood prone areas. Further, the shade loving hardy crop can be cultivated in orchards under the trees, which makes it a perfect choice for mixed or poly cropping systems like Navadhanya. Farmers of Pavagada, Madhugiri and Sira regions of the Indian state of Karnataka have been successfully cultivating brown top millet among tamarin orchards (Reddy and Govindaiah, 2021).

When the average yield per acre under Navadhanya cropping system in the present study was juxtaposed against the per acre yield of peanut suggested by IOPEPC (2017), it was found that the aggregate yield per acre of Navadhanya was found to be 60% higher than a mono-crop peanut farm. Mt.Pleasant, (2016) in the study on the traditional three sisters cropping system of the Haudensosaunee (Iroquois), (Fiorello, 2021; Murphy, 2018), found that the corn yield was significantly higher for the polyculture when compared to the different densities of monoculture, however, beans and squash suffered distinct reduction in the yield.

The most plausible explanation for better yields under mixed-crop or poly-crop systems may lie in complementarity, i.e., the component crops differ in their growth and nutritional requirements, therefore make better use of the available resources and also generate enhancement services such as pest and disease control, soil enrichment, increase of soil moisture & beneficial soil flora and fauna, among others (Gaba, et al 2015; De Bello, et al 2010). Further, the LER (Land Equivalent Ratio) value of 1.73 suggests that the sum of the yields of a mixture/poly crop can only be equaled to a monoculture planted 1.73 times the area divided proportionally among the crops of a mixture/poly-crop (Morales-Rosales and Franco-Mora 2009; Dariush, et al 2006).

(b) The Average Net Returns/acre of the Main Crop under Navadhanya at the Study Area

The average market price/quintal of peanut and brown top millet in the study area was INR 4579 and INR 4510 respectively. The per acre gross returns of peanut and brown top millet as the main crop was INR 21081 and INR 24308 respectively. And the average net returns of peanut and brown top millet was INR 16932 and INR 23988 respectively (*Figure - 11*). Perhaps the relatively higher margin of net returns of brown top millets than peanuts is due to relatively less investment cost of seeds.

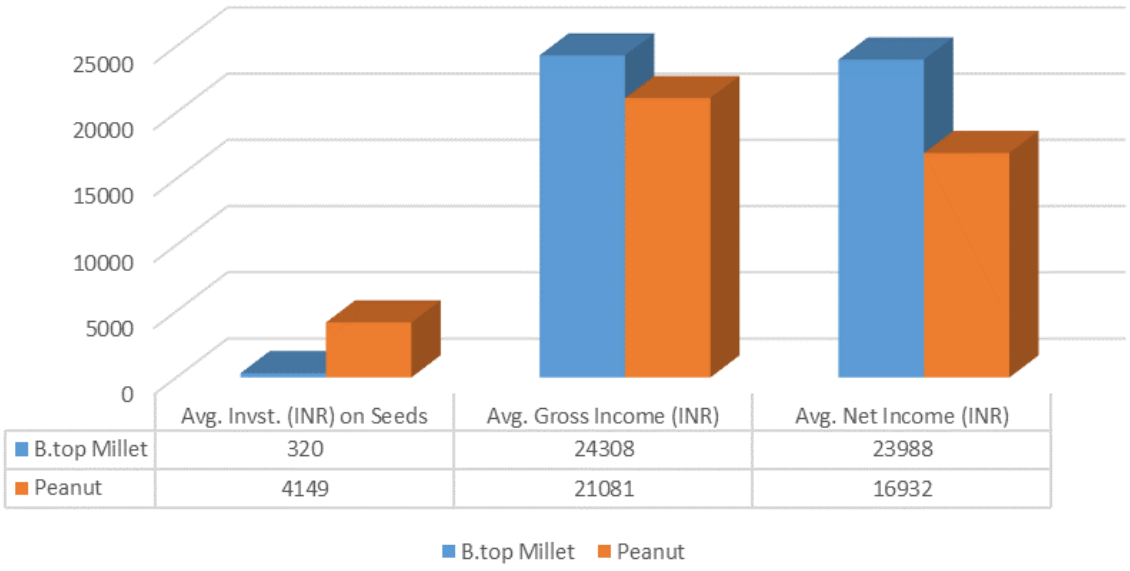


Fig. 11. *Average Income INR / acre of the Main Crop of Navadhanya Cropping System*

Based on the current market prices at the time of the study, the average returns reported by the participant farmers for each crop cultivated under Navadhanya cropping system were peanut (INR 23988/ac), brown top millet (INR 16932/ac), pigeon pea (INR 1653/ac), sorghum (INR 258/ac), pearl millet (INR 269/ac), cowpea (INR 1084/ac), castor (INR 814/ac), field bean (INR 1679/ac), green bean (INR 722/ac), kenaf (INR 213/ac) and fodder (INR 15022/ac), (*Figure–12*).

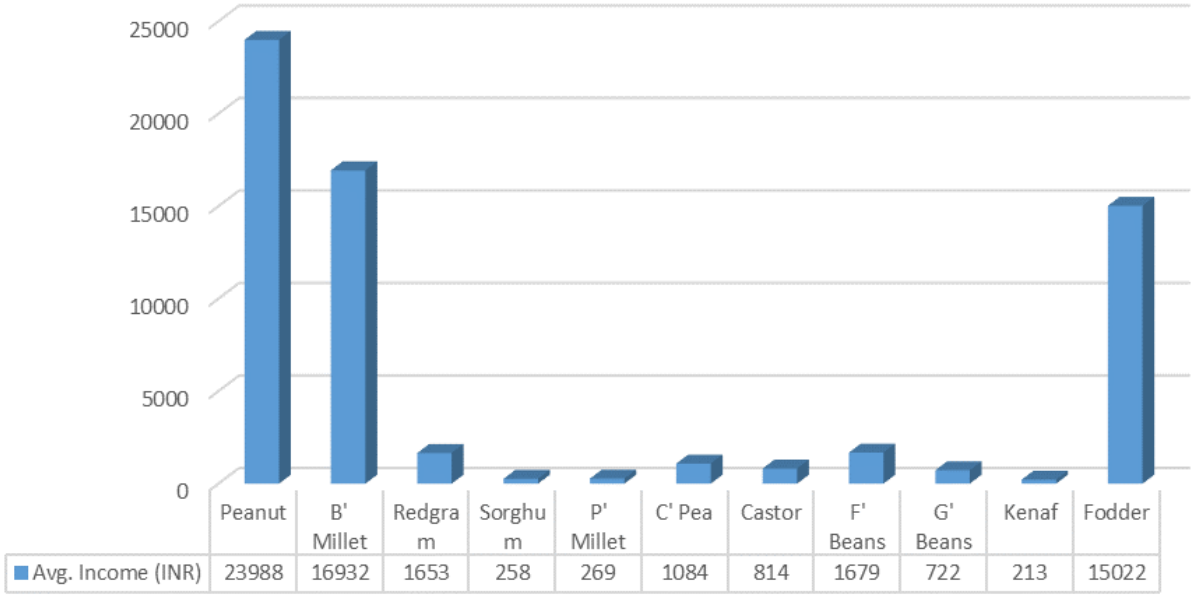


Fig. 12. *The Average Income (INR) / ac of the Different Crops of Navadhanya Cropping System in the Study Area*

Based on the current market prices the average gross returns per acre of Navadhanya cropping system was reported at INR 43054 and the average net returns per acre of Navadhanya cropping system was reported at INR 29108, (which is 2.1 times more than the investment) by the study farmers (*Figure - 13*).

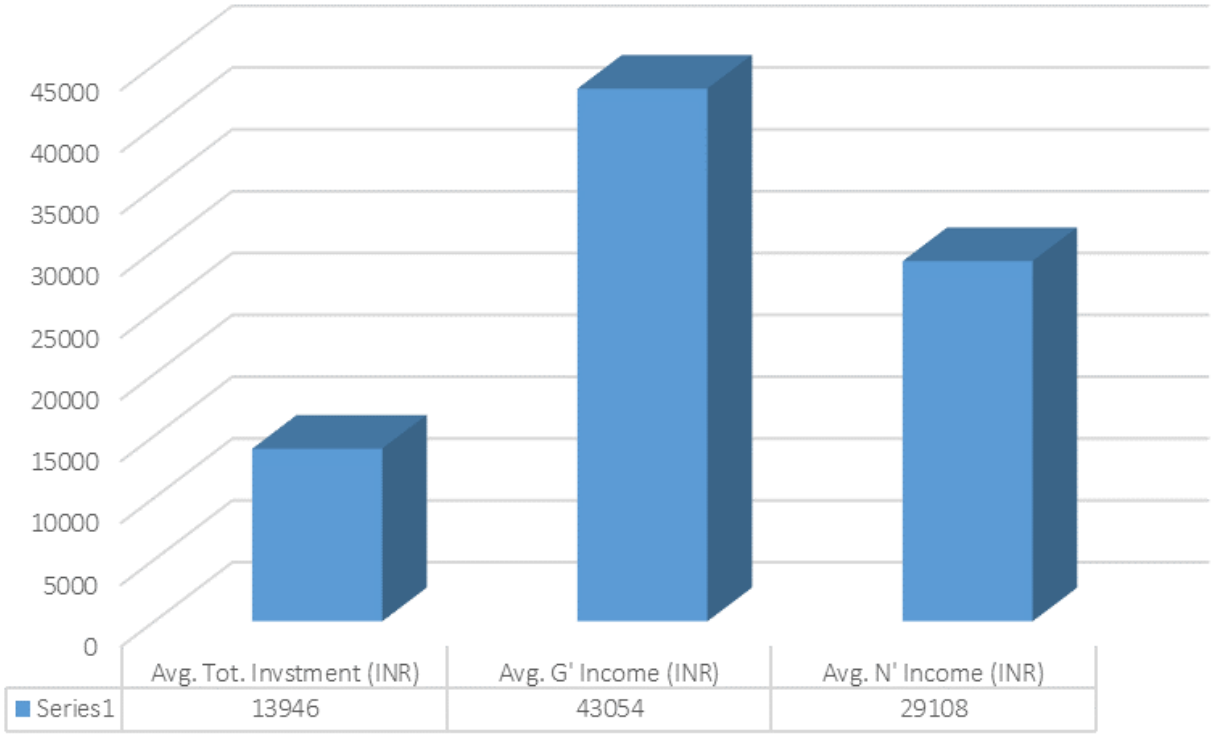
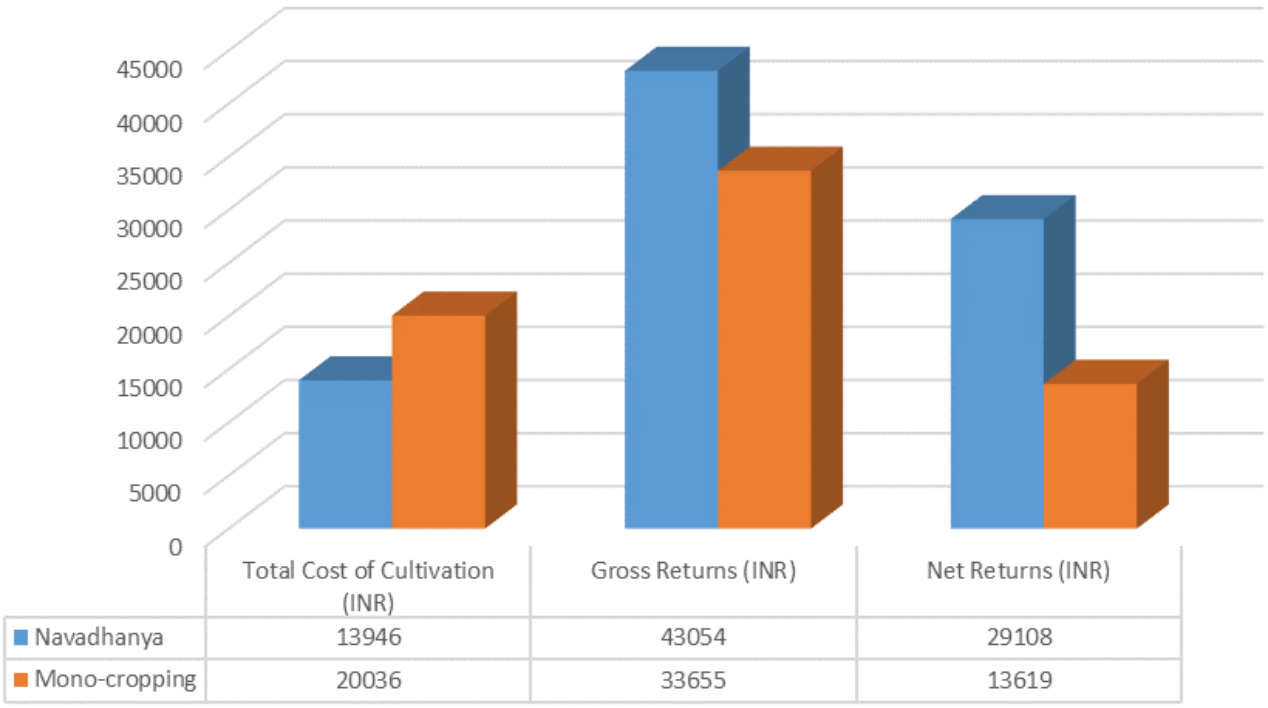


Fig. 13. *The Average Total Investment and Profit (in INR / ac) of Navadhanya Cropping System in the Study Area*

Naidu, et al (2019) found that gross returns per acre of the mono-cropping, irrigated small-size peanut farmers was INR 33655, and the net returns per acre of the same small-size peanut farmers was INR 13619, (*Table - 14)*.



	Total Cost of Cultivation (INR)	Gross Returns (INR)	Net Returns (INR)
Navadhanya	13946	43054	29108
Mono-cropping	20036	33655	13619

Fig. 14. *Economics of peanut cultivation under rainfed Navadhanya cropping and irrigated mono-cropping in Rayalaseema region*

4. CONCLUSION

Studies suggest that the rate of investment in peanut cultivation under mono-cropping and irrigated condition is inversely proportional, and net returns are directly proportional to increase in the landholding size in Ananthapuram region. Per acre/hectare cost of cultivation of peanuts under irrigated-mono-cropping conditions and application of synthetic fertilizers was fond to be highest for small-size farms and lowest for large-size farms of the same region. Small-size farmers cultivating peanuts under irrigated-mono -cropping conditions are more likely to incur losses due to relatively low returns and exposure to high risk of crop failure from erratic rainfall and volatile market prices in the study region. In this context it may be safe to assume that Navadhanya cropping system could be one of the best options available for the small-size farmers, as the composite is better than a component. The composite yield of different crops cultivated in the same plot under Navadhanya cropping system could insulate and protect farmers against vagaries of climate and fluctuating market prices, thereby increasing their resilience. Perhaps, small -size farmers should be encouraged and incentivized to practice Navadhanya in the study region for their own food and nutrition and household income security. However, further studies are necessary to ascertain the benefits of Navadhanya cropping system to farmers in general and small-size farmers in particular.

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