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Effect of Organic Manures on Productivity in a Groundnut-Wheat Sequence under Organic Farming

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during two consecutive*kharif* and *rabi* season from the year 2016-17 to 2018-19 for three years on to evaluate different organic sources performance on groundnut and wheat sequence under organic farming at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The soil of experiment was loamy sand. Experiment was carried out in *Large plot technique* design and with eight replication for four treatments. From three years experiment result revealed that in *kharif* season, application of 100% nitrogen through castor cake sequring higher pod yield of groundnut

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and application of 75% nitrogen through castor cake for succeding wheat in *rabi* season for getting higher seed yield. Application of castor cake in both season sequred higher groundnut equivalent yield. Maximum gross (Rs 150300/ha) and net neturn (Rs 67922/ha) with BCR of 1.82 was obtained under Treatment T_3 (100% RDN through castor cake in groundnut and 75% RDN through castor cake in succeeding wheat) under organic farming under North Gujarat Agro climatic conditions.

Keywords: Organic manures; castor cake; FYM;nitrogen; groundnut and wheat.

1. INTRODUCTION

"Groundnut (*Arachis hypogaea* L.) is also known as "The king of oilseeds". Groundnut is an important oilseed crop in India which occupies first position in terms of area and second position in terms of production after soyabean. China ranks first in groundnut production with 17.57 million tonnes followed by India 6.73 million tonnes. Among the states, Gujarat stood first in area coverage with 19.09 lakh ha followed by Rajasthan (7.76 lakh ha), Andhra Pradesh (6.27 lakh ha), Karnataka (4.75 lakh ha) and Madhya Pradesh (3.82 lakh ha)" (Groundnut Outlook - November 2021). "The optimization of the mineral nutrition is the key to optimize the production of groundnut, as it has very high nutrient requirement and the recently released high yielding groundnut varieties remove still more nutrients from the soil. On contrary groundnut farmers, most part of the semi-arid region use very less nutrient fertilizer and sometime only one or two nutrients resulting in severe mineral nutrient deficiencies due to inadequate and imbalance use of nutrients is one of the major factors responsible for low yield in groundnut. India is the world's largest producer of groundnut where nutritional disorders cause yield reduction from 30 to 70% depending upon the soil types. Thus it is high time to look into the mineral nutrition aspects of groundnut for achieving high yield and advocate the suitable package of practices for optimization of yield" [1]. Many studies have shown that organic farming methods can produce even higher yields than conventional methods. Significant difference in soil health indicators such as nitrogen mineralization potential and microbial abundance and diversity, which were higher in the organic farms can also be seen.

"Wheat (*Triticum aestivum*) is one of the most important cereal crops for the majority of world's population and India. It is second most important cereal crop next to rice contributing nearly 35 per cent to the national food and nutritional security. Wheat has been described as "King of cereal or staff of life." It finds a major place in meals of common population in major wheat growing states of India. The cultivation of wheat has also symbolic of green revolution" [2].

"Organic manures, valuable by-products of farming and allied industries, contribute to plant growth through their favourable effects on the physical, chemical and biological properties of soil. Organic manures also have a pronounced residual effect on the nutrient availability. Many benefits attributed to organic manures have well been documented" [3]. The addition of organic materials causes mineralization of more recalcitrant fraction of P through increased microbial activity and resultant biochemical transformation. Organic manure has a profound effect on improving soil physical, chemical and biological properties and enhancing productivity of field crops.

Farm yard manure improves the soil structure and is used as a natural fertilizer in farming. It increases the soil capacity to hold more water and nutrients. It also increases the microbial activity of the soil to improve its mineral supply and also the plant nutrients.

Vermicomposting is the scientific method of making compost, by using earthworms. They are commonly found living in soil, feeding on biomass and excreting it in a digested form. Vermiculture means "worm-farming". Earthworms feed on the organic waste materials and give out excreta in the form of "vermicasts" that are rich in nitrates and minerals such as phosphorus, magnesium, calcium and potassium. This process is mainly required to add nutrients to the soil. Compost is a natural fertilizer that allows an easy flow of water to the growing plants. The earthworms are mainly used in this process as they eat the organic matter and produce castings through their digestive systems.

"Castor Cake is a natural nitrogen fertilizer. It is a simple manure, which acts progressively that encourages soil microbial activity. It has insecticidal properties and naturally pest repellent. It is can be used in organic farming &

fits for any type of soil, with its high content of organic matter. Castor Cake is also the fertilizer for turf and lawns. This fertilizer promotes root development and winter cold hardiness" [4].

The aim of present study was to determine the influence of organic sources of nutrients in different combination on growth and yield of green gram-wheat cropping sequence grown in organic farming systems.

2. MATERIALS AND METHODS

An experiment was conducted during two consecutive*kharif* and *rabi* season from the year 2016-17 to 2018-19 for three years on to evaluate different organic sources performance on groundnut and wheat sequence under organic farming at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The soil of experimental field was loamy sand in texture. In *kharif* season groundnut seeds (120 kg/ha) were sown at a row distance of 45 cm and in *rabi* season wheat seeds (125 kg/ha) were sown at a row distance of 22.5 cm. Various growth and yield attributing characters of the crop were measured and studied during the course of investigations. Other management practices were followed as recommended. Statistical analysis of the data of various characters studied in present investigation was carried out with the help of computer as per appropriate procedure suggested by Panse and Sukhatme [5] for the design of experiment.

3. RESULTS AND DISCUSSION

2017-18: Table 11 indicated that significantly higher groundnut equivalent yield (2911 kg/ha) was recorded under treatment T_3 (100% RDN through castorcake in groundnut and 75% RDN through castor cake in succeeding wheat) over rest of the treatments. Application of 100% RDN through FYM in groundnut and 50% RDN through vermicompost in succeeding wheat (T_2) produced significantly lower groundnut equivalent yield (2487 kg/ha), but failed to differ significantly over treatment T_4 (100% RDN through Castor cake in groundnut and 50% RDN through castor cake in succeeding wheat). The results indicated that the residual effect of organic manures applied to preceding *kharif* groundnut resulted in saving of 25% RDN for succeeding r*abi* wheat.

2018-19: The data presented in Table11 indicated that significantly higher groundnut equivalent yield (3298 kg/ha) was noted under treatment T_3 (100% RDN through castor cake in groundnut and 75% RDN through castor cake in succeeding wheat) which was found at par with treatment T_1 (100% RDN through FYM in groundnut and 75% RDN through vermicompost in succeeding wheat). Application of 100% RDN through Castor cake produced significantly lower groundnut equivalent yield (2944 kg/ha). However it did not differ significantly over treatment T_2 (100% RDN through FYM in groundnut and 50% RDN through vermicompost in succeeding wheat).

List 1. Treatment details

Kharif	***Rabi***
Groundnut	**Wheat**
T_1 : 100% RDN through FYM	T_1 : 75% RDN through VC
T_2 : 100% RDN through FYM	T_2 : 50% RDN through VC
T_3 : 100% RDN through CC	T_3 : 75% RDN through CC
T_4 : 100% RDN through CC	T_4 : 50% RDN through CC

Note:

1. *Bio NPK consortium and bio-fertilizer was applied to both crops as seed inoculation @ 5 ml/kg of seed.*
2. *Experiment was conducted on fix site.*
3. *RDN of groundnut: 12.5 kg N/ha and wheat: 120 kg N/ha.*
4. *Phosphorus will not be applied.*
5. *Design: Large plot technique*
6. *Replications: Eight*
7. *Crop and variety: Groundnut, Gujarat Groundnut 20, Wheat, GW 451*

Table 1. Plant population of groundnut as influenced by different treatments

Treatments	Plant population of groundnut at 20 DAS				Plant population at harvest			
Groundnut	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:100%RDN through FYM	9.0	8.9	9.3	9.0	8.8	8.6	9.1	8.8
T_2:100%RDN through FYM	8.9	8.9	9.1	9.0	8.7	8.8	8.914	8.5
T_3:100%RDN through CC	8.9	9.0	9.0	9.0	8.6	8.9	8.810	8.8
T_4:100%RDN through CC	9.0	8.9	8.8	9.0	8.7	8.8	8.7	8.7
S.Em.±	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	5.59	6.14	6.30	6.02	5.33	5.61	6.25	5.92
YxT	-	-	-	NS	-	-	-	NS

Table 2. Plant height and number of branches per plant of groundnut as influenced by different treatments

Treatments	Plant height (cm)				Number of branches per plant			
Groundnut	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:100%RDN through FYM	32.5	34.0	35.0	33.9	6.9	7.3	7.7	7.3
T_2:100%RDN through FYM	32.3	33.8	34.9	33.7	6.8	7.2	7.4	7.1
T_3:100%RDN through CC	34.1	37.1	37.4	36.2	7.3	7.8	8.1	7.7
T_4:100%RDN through CC	33.8	36.1	37.3	35.8	6.7	7.5	7.9	7.3
S.Em.±	1.0	1.0	1.1	0.6	0.2	0.3	0.27	0.1
CD(P=0.05)	NS	NS	NS	1.81	NS	NS	NS	0.3
CV(%)	8.11	8.09	8.59	8.16	11.17	9.84	9.97	10.31
YxT	-	-	-	NS	-	-	-	NS

Table 3. Number of pods per plant and pod yield/plant of groundnut as influenced by different treatments

Treatments	Number of pods per plant				Pod yield/plant (g)			
Groundnut	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN through FYM	17.74	19.34	21.15	19.74	8.03	10.40	11.84	10.07
T_2:100%RDN through FYM	17.57	19.53	20.07	19.06	7.86	10.18	11.68	9.90
T_3:100%RDN through CC	19.12	20.98	24.15	21.42	8.57	11.05	12.55	10.72
T_4:100%RDN through CC	18.18	20.58	22.49	20.42	8.18	10.63	12.13	10.31
S.Em.±	0.54	060	0.77	0.36	0.45	0.40	0.40	0.23
CD(P=0.05)	NS	NS	NS	1.03	NS	NS	NS	NS
CV(%)	8.46	8.47	8.37	8.52	15.55	10.64	9.31	11.44
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 4. Oil content and shelling percentage of groundnut as influenced by different treatments

Treatments	Oilcontent(%)				Shellingpercentage			
Groundnut	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	46.54	46.58	46.51	46.54	59.50	60.79	64.65	61.65
T_2:100%RDN throughFYM	46.38	46.09	46.09	46.19	58.89	59.70	63.78	60.79
T_3:100%RDN throughCC	46.77	47.02	47.15	46.99	62.82	62.11	65.86	63.60
T_4:100%RDN throughCC	46.49	46.54	46.04	46.35	59.90	60.95	66.40	62.42
S.Em.±	0.72	0.80	0.74	0.51	1.36	1.50	1.76	0.86
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	4.38	4.84	4.50	4.83	6.37	6.95	7.62	7.04
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 5. Pod and haulm yield of ground nut as influenced by different treatments

Treatments	Podyield(kg/ha)				Haulmyield(kg/ha)			
Groundnut	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	1079	1158	1272	1170	1731	2046	2108	1961
T_2:100%RDN throughFYM	1063	1139	1254	1152	1713	2026	2096	1945
T_3:100%RDN throughCC	1101	1185	1313	1200	1807	2099	2205	2037
T_4:100%RDN throughCC	1092	1197	1299	1196	1772	2082	2175	2010
S.Em.±	44	39	44	23	53	61	67	34
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	11.38	9.35	9.76	10.14	8.59	8.38	8.79	8.63
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 6. Plant population of wheat at as influenced by different treatments

Treatments	Plantpopulationat20DAS				Plantpopulationofatharvest			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	26.7	26.1	27.4	26.7	25.9	24.9	26.2	25.7
T_2:50%RDN throughVC	26.0	25.6	26.8	26.1	25.5	24.6	26.0	25.4
T_3:75%RDN throughCC	27.3	26.9	28.1	27.5	26.6	25.7	27.4	26.6
T_4:50%RDN throughCC	26.9	26.4	27.5	26.9	26.4	25.2	26.9	26.2
S.Em.±	0.9	0.9	0.9	0.5	0.8	0.9	0.9	0.5
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	9.01	10.14	9.20	9.45	9.03	10.00	9.05	9.36
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 7. Plant height and number of tillers per plant of wheat as influenced by different treatments

Treatments	Plantheight(cm)				Numberoftillersperplant			
Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:75%RDN throughVC	73.23	71.83	74.85	73.30	4.1	4.6	4.9	4.55
T_2:50%RDN throughVC	70.60	68.38	72.38	70.45	3.8	4.0	4.5	4.11
T_3:75%RDN throughCC	80.96	79.04	83.26	81.09	5.0	5.3	5.7	5.34
T_4:50%RDN throughCC	71.83	70.25	73.06	71.71	3.9	4.4	4.8	5.36
S.Em.±	2.35	2.24	2.47	1.50	0.2	0.2	0.2	0.10
CD(P=0.05)	7.4	7.1	7.1	4.22	0.5	0.6	0.6	0.4
CV(%)	8.95	8.76	9.19	8.98	9.29	14.76	12.08	12.41
YxT	-	-	-	NS	-	-	-	NS

Table 8. Length of spike /plant and number of spikelet/spike of wheat as influenced by different treatments

Treatments	Lengthofspike(cm)				Numberofspikelet/spike			
Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:75%RDN throughVC	7.0	7.3	7.5	7.3	11.59	12.49	12.99	12.35
T_2:50%RDN throughVC	6.2	6.4	6.6	6.4	10.84	11.53	12.28	11.55
T_3:75%RDN throughCC	7.7	8.0	8.5	8.0	13.18	13.71	14.84	13.91
T_4:50%RDN throughCC	6.7	6.8	7.0	6.8	11.43	11.78	12.78	11.99
S.Em.±	0.2	0.2	0.2	0.1	0.40	0.39	0.44	0.23
CD(P=0.05)	0.7	0.7	0.7	0.4	1.18	1.14	1.28	0.64
CV(%)	9.33	10.23	9.17	9.59	9.62	8.86	9.33	9.28
YxT	-	-	-	NS	-	-	-	NS

Table 9. Number of grain perearhead and test weigh to fwheatas influenced by different treatments

Treatments	Numberofgrainperearhead				Testweight(g)			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	38.1	40.0	38.4	38.9	40.38	38.13	39.75	39.42
T_2:50%RDN throughVC	31.7	40.0	33.1	33.9	40.19	37.94	38.70	38.94
T_3:75%RDN throughCC	41.6	45.0	42.8	43.1	40.63	38.25	40.35	39.74
T_4:50%RDN throughCC	35.5	39.1	36.6	37.1	40.31	38.00	39.20	39.17
S.Em.±	1.1	1.6	1.3	0.8	0.79	0.87	0.78	0.45
CD(P=0.05)	3.2	4.7	3.9	2.1	NS	NS	NS	NS
CV(%)	8.36	11.12	10.05	10.00	5.53	6.50	5.62	5.88
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 10. Grain and straw yield of wheat as influenced by different treatments

Treatments	Grainyield(kg/ha)				Strawyield(kg/ha)			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	3569	4470	3988	4009	5136	5896	5229	5420
T_2:50%RDN throughVC	3050	4057	3588	3565	4488	5309	4701	4832
T_3:75%RDN throughCC	3936	4661	4427	4341	5594	5907	5775	5758
T_4:50%RDN throughCC	3294	3789	3718	3600	4779	5085	4858	4908
S.Em.±	115	120	115	68	142	162	157	89
CD(P=0.05)	339	353	339	191	417	477	461	251
CV(%)	9.41	8.00	8.26	8.51	8.03	8.26	8.62	8.32
YxT	-	-	-	NS	**-**	**-**	**-**	NS

Table 11. Ground nut equivalent yield as influenced by different treatments

Treatments		Groundnutequivalentyield(kg/ha)			
Groundnut	**Wheat**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	T_1:75%RDNthroughVC	2727	3195	3534	3152
T_2:100%RDN throughFYM	T_2:50%RDN throughVC	2487	2995	3302	2928
T_3:100%RDN throughCC	T_3:75%RDN throughCC	2911	3298	3813	3340
T_4:100%RDN throughCC	T_4:50%RDN throughCC	2624	2944	3420	2996
S.Em.±		66	58	77	38
CD(P=0.05)		193	169	225	108
CV(%)		6.92	5.24	6.15	6.11

Table 12. Economics of kharif ground nut as influenced by different treatments

	(Pooleddataof2017-18,2018-19and2019-20)					
Treatments	**Yield(kg/ha)**		**Gross return (Rs/ha)**	**Cost of cultivation (Rs/ha)**	**Net return (Rs/ha)**	**BCR**
	Pod	**Haulm**				
T_1:100%RDNthroughFYM	1170	1961	58533	36710	21823	1.59
T_2:100%RDNthroughFYM	1152	1945	57675	36710	20965	1.57
T_3:100%RDNthroughCC	1200	2037	60111	34108	26003	1.76
T_4:100%RDNthroughCC	1196	2010	59850	34108	25742	1.75

Rateofsellofproduceofgroundnut:

i) Pod:Rs45.00/kg
ii) Haulm:Rs.3.00/kg
iii) FYM:Rs1.50/kg
iv) Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)

Table 13. Economics of rabi wheat as influenced by different treatments (Pooled dataof2017-18, 2018-19 and 2019-20)

Treatments	Yield(kg/ha)		Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	BCR
	Grain	Straw				
T_1:75%RDNthroughVC	4009	5420	88422	60790	27632	1.45
T_2:50%RDNthroughVC	3565	4832	78666	52530	26136	1.50
T_3:75%RDNthroughCC	4341	5758	95412	48270	47142	1.98
T_4:50%RDNthroughCC	3600	4908	79524	44008	35516	1.81

Rateofsellofproduceofwheat:

(i) Seed:Rs18.00/kgseed
(ii) Stover:Rs.3.00/kgstalk
(iii) VC:Rs4.00/kg
(iv) Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)

Table 14. Economics of groundnut-wheat crop sequence as influenced by different treatments (Pooled data of 2017-18, 2018-19 and 2019-20)

Treatments		Groundnut equivalent yield (kg/ha)	Gross return (Rs/ha)	Costof cultivation (Rs/ha)	Net return (Rs/ha)	BCR
Groundnut	Wheat					
T_1:100%RDN through FYM	T_1:75%RDN throughVC	3152	141840	97500	44340	1.45
T_2:100%RDN through FYM	T_2:50%RDN through VC	2928	131760	89240	42520	1.48
T_3:100%RDN through CC	T_3:75%RDN through CC	3340	150300	82378	67922	1.82
T_4:100%RDN through CC	T_4:50%RDN through CC	2996	134820	78116	56704	1.73

Rateofsellofproduceofgroundnut:

(i) Pod: Rs 45.00/kg
(ii) Haulm: Rs.3.00/kg
(iii) FYM:Rs1.50/kg
(iv) Castor cake:Rs 6.0/kg(Rs300/50 kg bag of castor cake)
(v) Seed:Rs18.00/kgseed
(vi) Stover:Rs.3.00/kgstalk
(vii) VC:Rs 4.00/kg

2019-20: From Table 11, the highest groundnut equivalent yield (3813 kg/ha) was observed under treatment T_3 (100% RDN through castor cake in groundnut and 75% RDN through castor cake in succeeding wheat). Significantly lower groundnut equivalent yield (3302 kg/ha) was recorded under treatment T_2 (100% RDN through FYM in groundnut and 50% RDN through vermicompost in succeeding wheat) and failed to differ significantly over treatment T_4 (100% RDN through castor cake in groundnut and 50% castor cake in succeeding wheat).

4. DISCUSSION

Due to application of castor cake from the different studies reveled that it is control pH with increase in fertility, humas, residual effect, nitrogen supply for root. Castor cake do better soil aeration, inhibit termite and other pest. It might be attributed to multifarious role of castor cake in terms of nutrients supply as well as improvement in physical, chemical and biological properties of soil which finally reflected on growth of plantalso enhances the availability of major nutrients. Its positive impact on soil health and fertility [6]. Furthermore, findings from Sharma et al. [7-9] support these results, highlighting the beneficial effects of castor cake application on both wheat and groundnut yields in a crop rotation system.These studies emphasize the importance of castor cake as an effective organic fertilizer for improving yields and promoting sustainable agricultural practices in wheat-groundnut croppingsequences. Also simillar result was reported by Mahajan et al. [10], Dubey et al. [11], Nisha et al. [12] and Panwar et al. [13]. Phosphorous also helpful for root setting in early stage of plants leads to more nutrients availability resulted in better growth [14-16]. Though, organic manures having low content of nutrients, but when applied them with higher dose they are able to fulfill required major and minor nutrients. Supplementation of nutrients along with better soil physical condition at higher rate of both organic manure increased number of pods/plant and pod yield per plant which resulted into higher pod yield per hectare. The findings closely followed the results of Moinuddin and Zhong et al. [17,18].

5. ECONOMICS

Economics of different treatments (Table 14) under organic farming showed that maximum gross (Rs 150300/ha) and net neturn (Rs 67922/ha) with BCR of 1.82 was obtained with treatment T_3 (100% RDN through castor cake in groundnut and 75% RDN through castor cake in succeeding wheat). The lowest gross return (Rs.131760), net return (Rs.42520) and BCR (1.48) was observed under treatment T_2 (100% RDN through FYM in groundnut and 50% RDN through vermicompost insucceeding wheat).

6. CONCLUSION

Based on findings of three years experimentation, it is concluded that application of 100% recommended nitrogrn to groundnut and 75% recommended nitrogen to succeeding wheat crop through castorcake for obtaining higher groundnut equivalent yield and net return.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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