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Assessment of Physico-chemical Properties on Soil of Vizianagaram District, Andhra Pradesh, India

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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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Original Research Article

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ABSTRACT

The study was conducted at Sam Higginbottom University of Agriculture Technology and Sciences' Department of Soil Science and Agricultural Chemistry Lab. A total of 27 samples were collected from 3 blocks (Pusapatirega, Denkada and Bhogapuram), 9 villages, and analysed for physico-chemical properties using standard laboratory at varying depths (0-15, 15-30, and 30-45 cm). The soil colour ranged from yellowish red to yellowish brown (dry) and reddish brown to yellowish-brown (wet). It had a red sandy loam texture. Bulk density 1.402 (Mg m^{-3}), Particle density 2.603(Mg m^{-3}), Pore space 43.44(%), Water Holding Capacity 40.23(%), Specific gravity 2.42, pH 7.63 neutral, Electrical Conductivity 0.25 (dS m^{-1}) non- saline, and Soil Organic Carbon 0.37(%). Available Nitrogen 269.88(kg ha^{-1}) is low, Available Phosphorous and Available Potassium 17.34 and 191.09 (kg ha^{-1}) are medium. Exchangeable Calcium 4.63 (cmol kg^{-1}) and Exchangeable Magnesium 1.91 (cmol kg^{-1}) medium to high. Farmers need to maintain a soil health card, adopt proper management techniques, and provide adequate nutrients to the soil in order to overcome pollution.

Keywords: Soil pH; EC; available nitrogen; available phosphorous; available potassium; exchangeable calcium and magnesium; soil health.

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1. INTRODUCTION

Soil is the cradle for all crops and plants, it is the most crucial part of every farming sector. Every 250-1200 years, non-renewable resources appear. It could take another 3000-12,000 years for agriculture to become productive. This natural resource is scarce and cannot be replenished within a human lifetime [1]. The thin layer of material that covers the earth's surface is referred to as soil. It is made up of Organic matter, minerals, gases, water, and living beings that all work together to sustain life. Water storage, nutrient supply, and purification are all important functions of soil [2]. Pollutants affect minerals, Organic matter and the microbial ecology of the soil. Industrial effluent discharge, especially if it is not treated, can have a major impact on soil physico-chemical and biological features that are linked to soil fertility [3]. Because the physico-chemical qualities of soil affected food productivity and environmental quality, it's critical to have a fundamental understanding of these properties [4]. Physical attributes include soil texture, Bulk density, Particle density, Pore space , Water Holding Capacity, Soil structure and Soil colour. Chemical qualities include pH, EC, OC, Nitrogen, Phosphorus, Potassium, Exchangeable Calcium and Magnesium. Soil health is inextricably tied to soil microbial diversity and activity, which are important components of soil health. Healthy soils are essential for long-term development, not only for increased agricultural production as the world's population expands, but also for the long-term survival of essential ecosystem services [5].

2. MATERIALS AND METHODS

The present study, entitled – " Assessment of Physico-chemical properties of Soil in Vizianagaram district, Andhra Pradesh, India" was carried out during 2021-22 and comprised of a lab experiment which was carried out in the Department of Soil Science and Agricultural Chemistry, Naini, Agricultural institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.), India.

2.1 Study Area

The district is located in Andhra Pradesh's Northern Coastal plains and covers geographical area 6,539 Sq. kms. Between 17^0-15^1 and 19^0-15^1 North latitude and 83^0-0^0 to 83^0-45^1 East longitude. To the north, the state of Orissa, to the west and south, the district of Srikakulam and to the south, the Bay of Bengal. The district's agriculture is rainfed, with an average annual rainfall of 1131mm. The main crops grown in the district are Paddy, Ragi, Bajra, Sugarcane, Pulses, Mesta, Cotton and Groundnut.

2.2 Soil Sampling

Total of 27 samples are collected from 3 blocks (Pusapatirega, Denkada, Bhogapuram) and 9 villages at different depths of 0-15cm, 15-30 cm, and 30-45cm in the Vizianagaram district. At first foreign were removed from the sampling place and 'V'- shaped pit was dug out with the help of spade / khurpi / crowbar. After that, the soils were properly mixed before being divided into four equal pieces. After eliminating two opposite quarters, the two remaining soil quarters were mixed up. Before being delivered to the laboratory, the soil was packed in a poly bag and labelled with the sample number, sample location, area, farmer information, crop data and sampling date. The soil samples were dried in the shade and manually crushed with a mallet before being sieved in the laboratory with a 2mm sieve mesh. The acquired material's physical and chemical characteristics were investigated.

2.3 Analysis of Physico-chemical Prarameters

The hydrometer method was used to analyse the texture of soil particles less than 2mm [6] and the Soil Colour was tested by using the Munsell colour chart [7]. By using a graduated 100ml measuring cylinder, the bulk density, Particle density, Pore space, and Water Holding Capacity were calculated [8]. The Specific gravity of soil was determined using the relative density bottle or pycnometer method [9]. A digital pH metre and the 1:2.5 soil-water suspension method were used to determine the EC [10]. Wet oxidation was used to measure Organic Carbon [11]. Using the alkaline Potassium permanganate method, the Available Nitrogen was measured [12]. Using the colorimetric approach, the Available Phosphorus was determined [13].The flame Photometer method was used to determine the amount of Available Potassium [14]. A digital EC metre and the 1:2 Soil-Water suspension method were used to determine the pH. The

neutral Ammonium Acetate extraction method or the EDTA method was used to determine Exchangeable Calcium and Magnesium [15].

2.4 Stastical Analysis

The analysis of variance (ANOVA) approach was used to statistically analyse the data obtained throughout the study [16]. The experiment used ANOVA with two components and no replication. The analysis used a completely randomised experiment design (CRD). It is utilised when the experimental units are homogeneous since it just requires two basic experimental design principles: replication and randomization. Researchers used the F'9 variance ratio test to determine which treatment effects were significant and which were not.

3. RESULTS AND DISCUSSION

3.1 Physical Properties

Yellowish red to Pale brown, yellowish-red to yellowish-brown and yellowish-red to yellowish-brown were among the soil colours (dry condition). The soil was a mix of reddish brown and yellowish red, yellowish red and yellowish brown, yellowish red and yellowish brown (wet condition). The texture was red sandy loam, with sand content ranging from 62.56 to 83.78%, silt from 19.16 to 42.15%, and clay from 5.42 to 16.04% and similar findings were reported [17]. The Bulk density ranged from 1.33 to 1.50 (Mg m^{-3}), with a mean of 1.402 (Mg m^{-3}). In [18], non-significant changes related to depth and site were discovered. As soil depth increases, Bulk density increases. The Particle density ranged from 2.54 to 2.69 (Mg m^{-3}), with 2.603 (Mg m^{-3}) being the average. Non-Significant differences related to depth and significant differences due to site were found [18]. Particle density is influenced by the mineral content of soil particles [19]. Pore space (%) ranged from 26.39 to 50.78 %, with 43.44% as the mean. Significant differences were found related to depth and site, and similar findings were reported in [20]. Water Holding Capacity (%) ranged from 32.73 to 48.41%, with 40.23% as the mean. Significant differences were found related to depth and site and similar findings were reported in [21]. Because of soil compaction and pore space contraction, WHC values decrease as depth increases. The Specific gravity ranged from 2.16 to 2.61, with 2.42 as the mean. A significant difference was found due to depth and site and similar findings were reported [18].

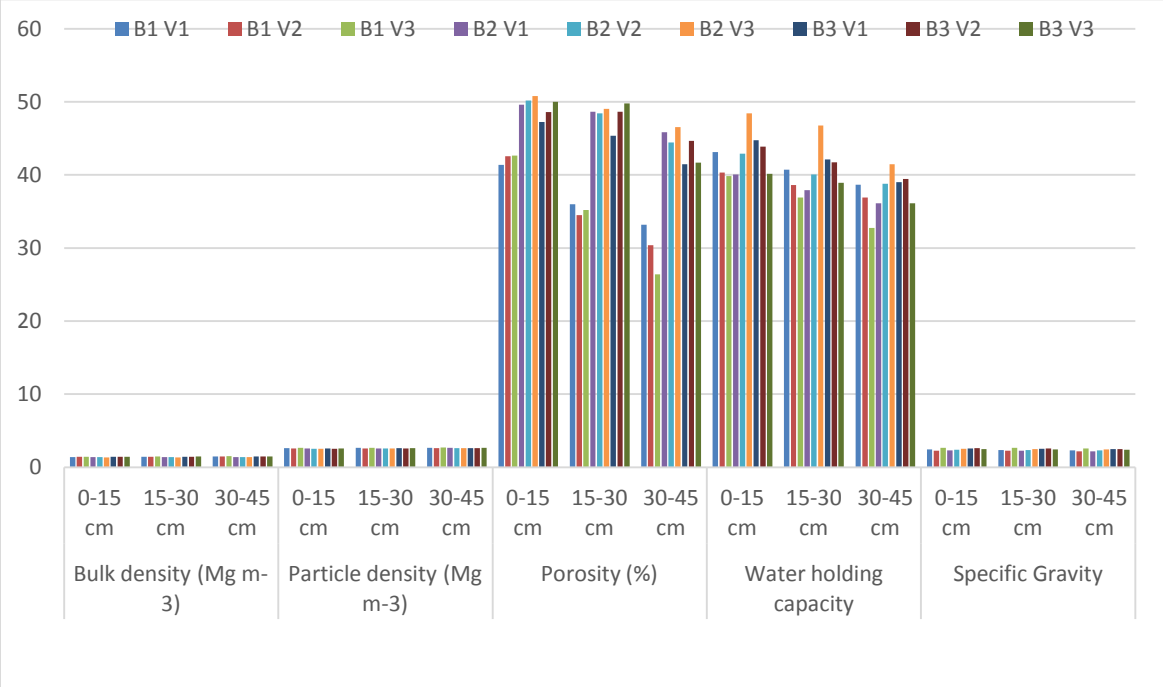

Fig. 1. Bulk density (Mg m-3), Particle density (Mg m-3), Porosity (%), WHC (%) and Specific gravity are all represented graphically

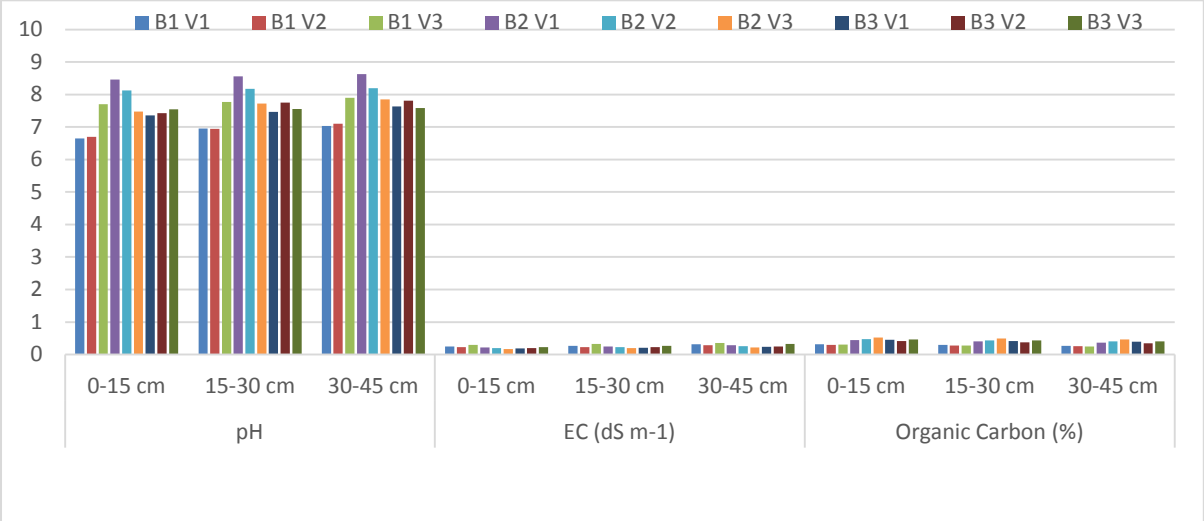

Fig. 2. Graphical representation of pH, EC (dS m^{-1}), Organic Carbon (%)

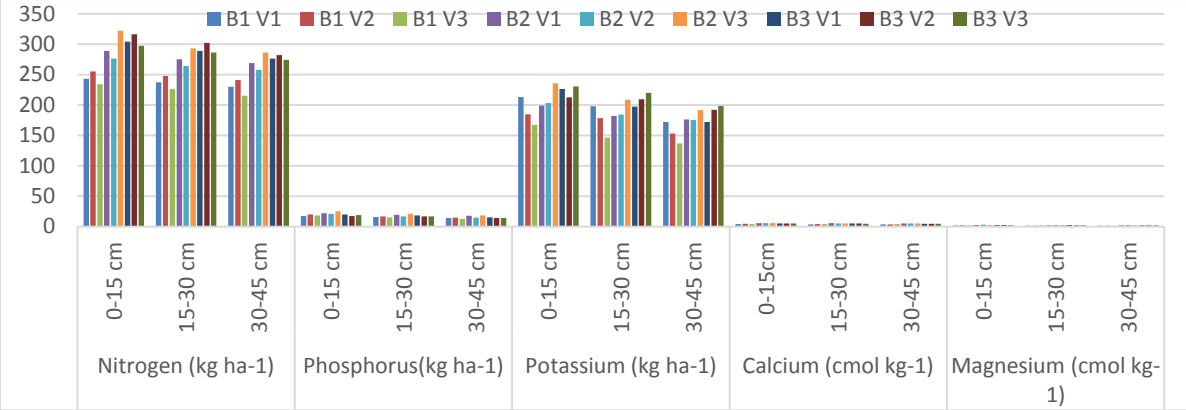

Fig. 3. Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}), Potassium (kg ha^{-1}), Exchangeable Calcium and Magnesium (cmol kg^{-1}) are represented graphically

Table 1. Assessment of Db, Dp, Porosity, WHC and Specific Gravity of Vizianagaram district

Sample No.	Bulk Density(Mg m^{-3})			Particle Density (Mg m^{-3})			Porosity(%)			Water Holding Capacity (%)			Specific Gravity		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
$B_1 V_1$	1.4	1.43	1.46	2.61	2.64	2.68	41.37	35.98	33.2	43.14	40.72	38.64	2.42	2.37	2.33
$B_1 V_2$	1.42	1.45	1.48	2.56	2.58	2.6	42.57	34.49	30.38	40.31	38.62	36.91	2.28	2.25	2.16
$B_1 V_3$	1.43	1.46	1.5	2.65	2.67	2.69	42.64	35.2	26.39	39.86	36.91	32.73	2.68	2.64	2.59
$B_2 V_1$	1.39	1.41	1.41	2.56	2.59	2.64	49.6	48.64	45.83	40.06	37.91	36.13	2.31	2.28	2.18
$B_2 V_2$	1.37	1.39	1.4	2.55	2.58	2.61	50.19	48.44	44.44	42.89	40.05	38.78	2.4	2.36	2.31
$B_2 V_3$	1.33	1.35	1.39	2.54	2.57	2.6	50.78	49.02	46.53	48.41	46.75	41.47	2.52	2.47	2.44
$B_3 V_1$	1.42	1.44	1.46	2.56	2.6	2.63	47.26	45.38	41.44	44.76	42.13	39.01	2.57	2.53	2.49
$B_3 V_2$	1.43	1.45	1.48	2.55	2.59	2.62	48.62	48.64	44.65	43.87	41.72	39.43	2.61	2.56	2.5
$B_3 V_3$	1.43	1.46	1.49	2.58	2.61	2.64	50	49.8	41.66	40.16	38.91	36.13	2.48	2.43	2.39
	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%
Due to depth	NS	-	-	NS	-	-	S	3.831	1.44	S	2.461	3.08	S	0.048	0.00026
Due to site	NS	-	-	S	0.032	1E-10	S	5.863	8.83	S	2.704	1.27	S	0.136	4.41

Table 2. Assessment of pH, EC, Organic Carbon, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium of Vizianagaram district

Sample No.	pH			EC (dS m^{-1})			Organic Carbon (%)			Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})			Calcium (cmol kg^{-1})			Magnesium (cmol kg^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
$B_1 V_1$	6.65	6.95	7.03	0.25	0.27	0.32	0.32	0.3	0.27	243	237	230	17.23	15.47	13.87	212.98	197.65	172.14	3.82	3.66	3.23	1.68	1.42	1.24
$B_1 V_2$	6.7	6.94	7.1	0.23	0.23	0.29	0.3	0.28	0.26	255	248	241	19.82	16.67	14.53	184.45	178.04	152.87	4.25	4.04	3.68	1.76	1.54	1.4
$B_1 V_3$	7.7	7.77	7.9	0.3	0.33	0.36	0.31	0.28	0.25	234	226	215	18.12	14.87	12.64	167.05	146.23	136.62	4.16	4.02	3.74	1.72	1.63	1.44
$B_2 V_1$	8.46	8.56	8.63	0.22	0.25	0.29	0.44	0.4	0.37	289	275	269	22.07	19.46	17.72	198.75	182.16	176.34	5.66	5.39	5.02	2.18	1.86	1.74
$B_2 V_2$	8.13	8.17	8.19	0.2	0.23	0.26	0.47	0.43	0.4	276	264	258	20.63	16.69	14.37	202.75	184.19	175.09	5.37	5.14	4.96	2.69	2.44	2.18
$B_2 V_3$	7.48	7.72	7.85	0.17	0.2	0.22	0.52	0.49	0.46	322	293	286	24.82	20.71	18.63	235.65	208.02	191.31	5.45	5.11	4.84	2.38	2.18	1.94
$B_3 V_1$	7.36	7.47	7.63	0.19	0.21	0.24	0.45	0.41	0.39	304	289	276	19.98	18.07	15.04	226.07	196.94	172.18	5.18	4.93	4.76	2.24	2.14	2.02
$B_3 V_2$	7.43	7.75	7.81	0.2	0.23	0.25	0.41	0.38	0.35	316	302	282	17.26	16.41	13.8	212.63	209.13	192	5.04	4.84	4.62	2.14	2.06	1.9
$B_3 V_3$	7.54	7.55	7.58	0.23	0.27	0.33	0.46	0.43	0.4	297	286	274	18.84	16.73	14.06	230.34	219.65	198.46	4.95	4.74	4.41	2.02	1.93	1.89
	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%	F-test	S.Ed. (+)	C.D.@5%
Due to depth	NS	-	-	S	0.0318	2.31	S	0.076	3.428	S	11.421	1.07	S	11.421	1.07	S	16.87	3.04	S	0.257	1.41	S	0.17	0.013
Due to site	S	3.391	0.00002	S	0.0405	1.041	S	0.0294	1.762	S	27.71	3.16	S	27.719	3.16	S	20.62	2.74	S	0.63	1.89	S	0.324	0.001

3.2 Chemical Properties

The pH of the soils ranged from 6.65 to 8.63, indicating neutral to slightly alkaline conditions, with a mean of 7.63. The change in depth isn't considerable, but the difference in location. Because the top horizons absorb the most leaching from rainfall and dissolved carbonic acids, as well as a high volume of Exchangeable Sodium ions, the pH value rises with depth. Similar research was conducted by Okolo, et al. [22]. Non-saline soils were identified by Electrical Conductivity ranging from 0.17 to 0.36 (dS m^{-1}), with a mean of 0.25 (dS m^{-1}). The Soil Organic Carbon (%) ranged from 0.25 to 0.52 %, suggesting productive soils, with 0.37% being the mean. Because surface soil includes undecomposed and partially degraded Organic Matter, whereas subsoil contains decomposed Organic Matter that has undergone chemical and biological changes, Organic Carbon declines with depth [23].

Available Nitrogen ranged from 215.00 to 322.00 (kg ha^{-1}), with a mean of 269.88 (kg ha^{-1}). Because Available Nitrogen is positively connected with Organic Matter concentration, which reduces with depth, and may be owing to greater pH at deep, Available Nitrogen decreases with depth. Similar research was conducted by [24]. Available Phosphorous ranged from 12.64 to 24.82 (kg ha^{-1}) with increasing depth, the amount of Available Phosphorus decreases. The presence of more accessible Phosphorous in surface soil may be due to a favorable soil pH and Organic Matter concentration. Similar research was conducted by Wani, et al. [25]. The Available Potassium ranged from 136.62 to 235.65(kg ha^{-1}) with a mean of 191.09 (kg ha^{-1}). The amount of Available Potassium reduces as you go deeper into the earth. The release of Available Potassium from Organic residues and the application of Potassium fertilizers may be responsible for the high quantity of accessible Potassium on the surface soil. A similar result was found by Singh, et al. [26]. The Exchangeable Calcium ranged from 3.23 to 5.66 (cmol kg^{-1}) with a mean of 4.63 (cmol kg^{-1}). The content of Exchangeable Magnesium ranged from 1.24 to 2.69 (cmol kg^{-1}) with a mean of 1.91 (cmol kg-1) Pushpanjali [3], Prasadini [27], Raju [17] and Ramana, et al. [28] all found significant differences in depth and site.

3.3 Soil Health Card for the Farmers of Vizianagaram District

A Soil health card is being produced for the villages' farmers. This would aware them, about the fertility status of their farm soil, help them to make practical decisions in adopting the farming techniques, and guide them to incorporate suitable doses of fertilizers (nutrients) based on the soil test there by improving soil productivity and crop yield leading towards increasing farm income [29,30].

4. CONCLUSION

The present investigation was done on the soils of the Vizianagaram district, and it revealed that the soils were red sandy loam soils with a considerable amount of Bulk density and good physical condition. It has a neutral pH and all soil samples are non-saline, making it good for all crops. Available Nitrogen is low because soil Organic Carbon is low. Available Phosphorous and Available Potassium are both available in moderate amounts. Exchangeable Calcium and Magnesium levels are medium, while macronutrient levels are low to medium. At some locations, the secondary nutritional deficiency was discovered. Nutrient deficits can be alleviated by using organic and inorganic fertilizers. It demonstrates that the soils are suitable for Paddy, Ragi, Bajra, Sugarcane, Pulses, Mesta, Cotton and Groundnut agriculture. Farmers must keep a Soil Health Card in accordance with central, ICAR, and state government recommendations for crop production, and are advised to use appropriate management strategies and supply proper nourishment to soil health.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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