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A Comprehensive Analysis of Chemical Applications for the Production of Brinjal Crop

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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

Brinjal (*Solanum melongena* L.), commonly known as eggplant, is a crucial vegetable crop cultivated extensively in tropical and subtropical regions. Chemical applications in brinjal cultivation, encompassing fertilizers, pesticides, and growth regulators, play a significant role in enhancing yield

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and quality. This comprehensive analysis reviews the latest advancements and methodologies in the chemical management of brinjal crops. It discusses the optimized use of synthetic and organic fertilizers for nutrient management, the strategic application of pesticides for pest and disease control, and the use of plant growth regulators to improve crop growth and productivity. Recent studies emphasize the importance of integrated pest management (IPM) practices to minimize chemical residues and environmental impact. In the Puducherry district, data was collected from five brinjal-growing villages out of sixty-two, utilizing a combination of closed-ended questionnaires for independent variables and open-ended questionnaires for dependent variables. In-person interviews were conducted to gather comprehensive data, which was then evaluated using a range of appropriate and standardized statistical tools. The study identified three dependent variables and fifteen independent factors, focusing on the evaluation of chemicals used in brinjal production, methods for handling these chemicals, and their effects on human health.

Keywords: Brinjal cultivation; chemical use; fertilizers; micro-nutrients and pesticides.

1. INTRODUCTION

Agriculture has always been a crucial driver of the economy in self-sustaining and developing nations. It supplies essential raw materials for the food and feed industries, which are vital for supporting the rapidly growing global population of nearly 7.5 billion people. Agriculture has the potential to significantly transform a country's economy by promoting globalization, technological advancement, economic growth, environmental remediation, biodiversity conservation, and food security and safety [1]. However, the agricultural sector currently faces numerous challenges, including declining crop yields, soil nutrient deficiencies, climate change, water scarcity, decreasing soil fertility, degradation of organic matter in the soil, crop diseases, limited awareness of genetically modified organisms, and an inadequate workforce [2]. To address these challenges, agrochemicals, including both fertilizers and pesticides, have become essential in modern agriculture due to their ability to increase yields with relatively less effort [3]. Research by Srivastav [4] indicates that a balanced application of fertilizers is sufficient to boost production. Examples of inorganic or chemical fertilizers include nitrogen, phosphate, and potassium, while organic fertilizers include manures (yard and green) and composts (including vermicomposts). Among the significant crops, the purple, green, or white pendulous fruit of *Solanum melongena L.*, commonly known as aubergine, stands out as one of the most important vegetables worldwide. It belongs to the Solanaceae family and shares a close resemblance with potatoes and tomatoes. India is the birthplace of eggplants, and they have been grown extensively in southern and eastern Asia. Now, brinjal (aubergine) is ranked third in global importance after potatoes and tomatoes. In India, approximately 08 million farmers cultivate brinjal, meeting the needs of over 160 million individuals [5]. Globally, brinjal (*Solanum melongena L.*) is grown extensively, covering 1.86 million hectares with an annual production of 54.08 million tonnes valued at over US$10 billion. Almost 84% of brinjal production is concentrated in China (61%), followed by India (23%). In India, brinjal cultivation spans 711.30 thousand hectares, with an estimated annual production of 13,557.80 thousand metric tonnes and a productivity of 19.10 metric tonnes per hectare. In Chhattisgarh, India, it is grown on 35,173 hectares with an annual output of 642,335 metric tonnes and a productivity of 18.26 metric tonnes of fruits per hectare, which is lower than the national average [6]. Insects are major pests of crops and cause considerable damage to food crops. They can cause extensive damage to the quality and quantity of the harvest resulting in significant economic losses [7]. The nature of vegetables is a higher productivity nature in a short duration with a valuable source of income source for the improvement of livelihood [8]. Harmful synthetic chemical pesticides have been applied extensively in India to prevent early brinjal fall and boost yield. Premature brinjal fall prevention is becoming increasingly dependent on controlling fungus and insect attacks across the nation. Farmers to apply pesticides 80–100 times during a single planting season to protect their brinjal. The World Health Organization (WHO) report that 20 per cent of pesticide use in the world is concentrated in developing countries, posing a risk to human health and the environment. Families residing in agricultural areas have elevated pesticide levels in their bodies [9]. This study aims to provide a clear analysis of the use of organic and inorganic chemicals in agriculture and their correlation with the socio-economic profile of brinjal growers.

2. MATERIALS AND METHODS

2.1 Study Area

Four districts, spread across many Indian states, are situated within Puducherry's union territory i.e., Yanam in Andra Pradesh, Mahe in Kerala, Puducherry, and Karaikal in Tamil Nadu. Due to its higher farmer population and brinjal farming region compared to other districts within the Union Territory of Puducherry, the Puducherry district was specifically chosen as the study location. Five communities out of 62 that cultivate brinjal were selected, with each village contributing ten samples, total 50 samples.

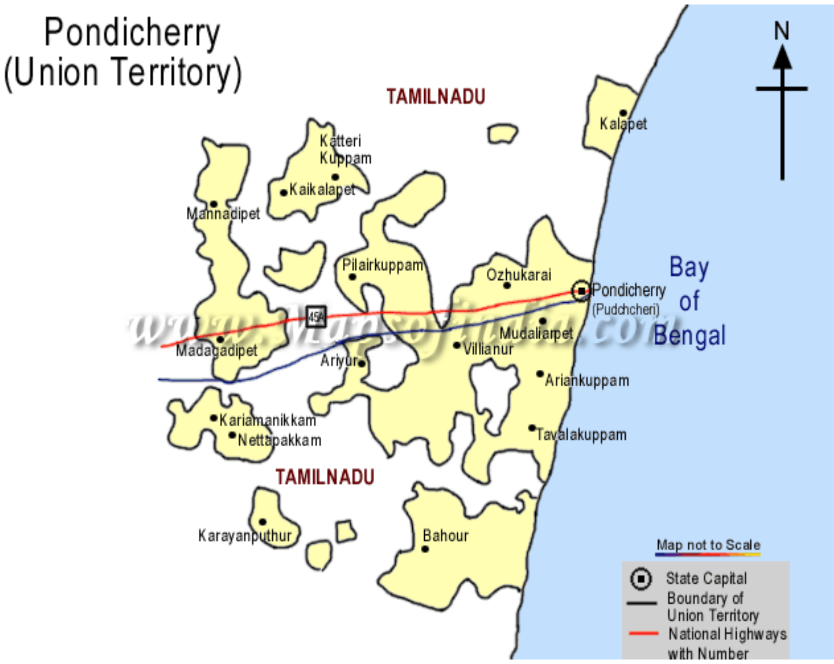

Fig. 1. Map of selected districts

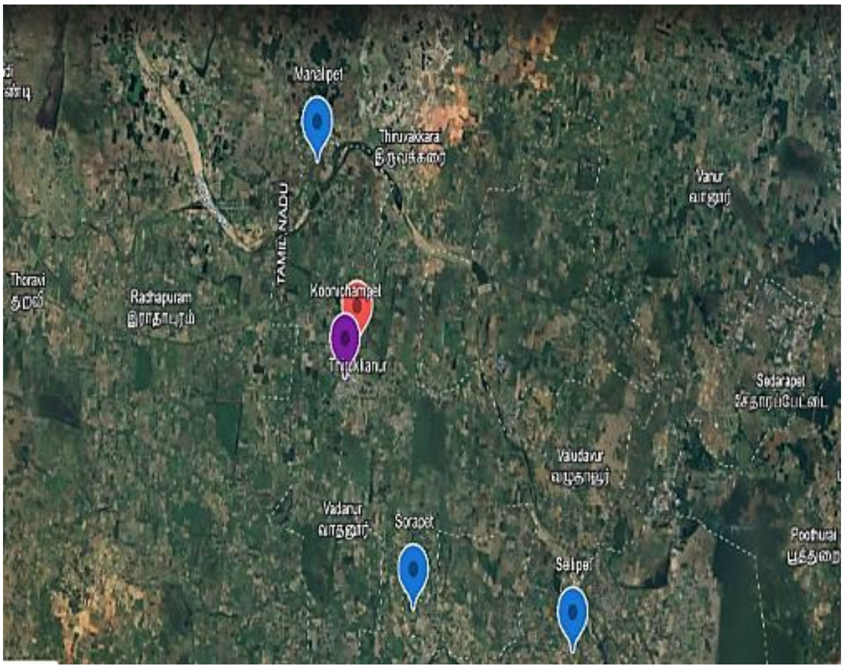

Fig. 2. Pinpoint the selected villages using google Earth

2.2 Research Design

The investigation used an ex-post facto design and purposive sample techniques. Excluding the sample farmers, there were ten participants in the pre-test interviews. To ascertain whether or not the questions were appropriate, suggestions and revisions were essential after the pilot survey. The study was helpful, timely, and had a clear objective. Farmers cultivating brinjal provided information through in-person interviews. The schedule includes both closed-ended and open-ended questions based on actual needs. To obtain firsthand information for the research study, the data was collected through interpersonal or face-to-face communication. Each interview schedule verifies and double-verifies the information provided by brinjal farmers.

2.3 Statistical Analysis

Frequency, Arithmetic Mean, Standard deviation (S.D), Pearson's Correlation Coefficient (r), and 't'– test. Sample farmers provided the data, which were then analysed using statistical software that can be utilised in Microsoft Excel for data analysis. After that, the data analysis could be developed into an objective-oriented form, which was necessary for tabulation, graphic representation, categorization, and quantitative numeric forms.

3. RESULTS AND DISCUSSION

The larger amounts of organic manures should be administered in a smaller quantity than what is advised. more fertilizer than is advised being applied. More micronutrients were used than were advised. In the same way, the plant growth regulator was applied in higher amounts than advised. a group of chemicals used as pesticides that are applied in amounts that are either the same or less than those that are advised.

Table 2 demonstrated that, there was no positive coefficient of correlation (r-value) between the application of organic manure (Y_1) and the independent variables (X1 to X15). The application of organic manures was positively and non-significantly correlated with the independent variables of age, family size, house type, maternal possession, technology adoption of television, smartphone, and two-wheeler, irrigation, farm mechanization and impersonal cosmopolite in source of information, and social participation.

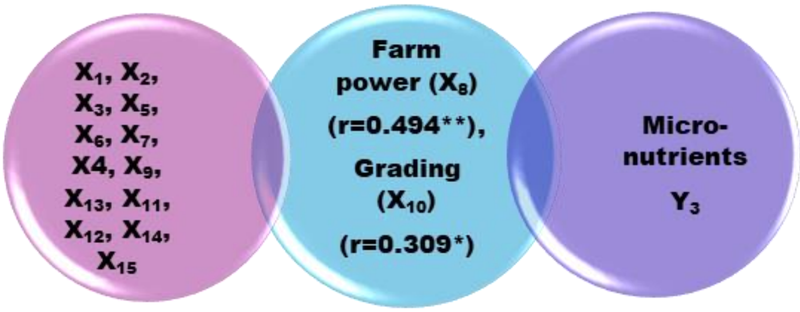

Fig. 3. Coefficient of correlation (*r* value) between application of Micro-nutrients (Y_3) and independent variables (X_1 to X_{15})

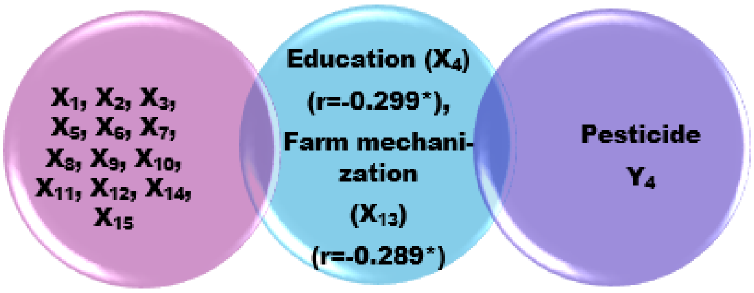

Fig. 4. Coefficient of correlation (*r* value) between application of Pesticides (Y_4) and independent variables (X_1 to X_{15})

Table 1. Application of organic and inorganic chemicals in Puducherry

Sl. No	Application of Chemicals	Doses (Kg / Acre)			
		Recommended	Mean	Max.	Min.
A.	**Organic Manure**				
1.	Farmyard Manures	1000	345	750	250
2.	Vermicompost	500	432	750	300
B.	**Fertilizers**				
1.	Fractomphos (19:19:0:13)	400	777	1250	300
2.	DAP (18:46)	100	154	200	100
3.	Complex (IPL- All -17)	400	184	200	100
C.	**Micronutrient**				
1.	Sulphur	0.5	1.58	2	1
2.	Boron	0.15	0.34	0.5	0.3
D.	**Plant Growth Hormone**				
1.	Gibberellic Acid – 0.001%	0.1	0.19	0.25	0.12
E.	**Pesticides**				
	Organophosphate				
1.	Monocrotophos	0.35	0.35	0.4	0.3
2.	Choloropyriphos 20% EC	0.25	0.25	0.3	0.2
3.	Acephate 75% SP	0.25	0.26	0.35	0.2
	Pyrethroids				
4.	Cypermethrin 25% EC	0.25	0.26	0.3	0.25
	Benzene Dicarboxiamides				
5.	Flubendamide 20% w/w	0.1	0.10	0.12	0.1
	Neo-Nicotinoid				
6.	Imidacloprid 17.8% SL	0.1	0.10	0.12	0.05
7.	Acetamiprid 20% SP	0.1	0.14	0.2	0.1
8.	Thiamethoxam 25%WG	0.1	0.09	0.12	0.07
	Avermectin				
9.	Emamectin Benzoate 5%SG	0.1	0.11	0.17	0.1
10.	Dimethoate 30% EC	0.25	0.24	0.35	0.2
11.	Profonophos 50% EC	0.25	0.26	0.3	0.25
12.	Flonicamide 50% w/w	0.15	0.13	0.2	0.1
13.	Phenthoate 50% EC	0.25	0.24	0.25	0.2

Sl. No	Application of Chemicals	Doses (Kg / Acre)			
		Recommended	**Mean**	**Max.**	**Min.**
14.	Chloranthranil 18.5% w/w SC	0.05	0.05	0.06	0.05
15.	Propargite 57% EG	0.25	0.24	0.25	0.2
	Phenyl pyrazole				
16.	Fipronil 5%SC	0.25	0.23	0.25	0.2
	Fungicides				
17.	Carbendazim 50% WP	0.25	0.24	0.27	0.2
18.	Difenoconozole 25% EC	0.1	0.11	0.8	0.1
19.	Copper Oxy Chloride 50% WP	0.5	0.49	0.5	0.45
20.	Azoxystrobin 8.3%WG+ Mancozeb 66.7% WG	0.25	0.24	0.25	0.22

(Source: Primary and Secondary data)

Table 2. Correlation between application of organic manures and independent variables

X	Variables	Y_1	(n=50)
		Pearson's Correlation Coefficient (*r* value)	***P* value**
1.	Age	0.153 NS	0.289
2.	Caste	-0.188 NS	0.191
3.	Occupation	-0.108 NS	0.454
4.	Education	-0.079 NS	0.583
5.	Land	-0.21 NS	0.143
6.	Family: Type	-0.052 NS	0.72
	Family: Size of Family	0.044 NS	0.761
7.	House	0.126 NS	0.385
8.	Farm Power	-0.034 NS	0.814
9.	Maternal possession	0.246 NS	0.085
10.	Grading	-0.147 NS	0.307
11.	Technology Adoption:		
	Radio	-0.169 NS	0.242
	Television	0.005 NS	0.971
	Smart Phone	0.078 NS	0.59
	Two-Wheeler	0.002 NS	0.991
	Car	0.00 NS	0.00
12.	Irrigation	0.26 NS	0.068
13.	Farm Mechanization	0.059 NS	0.682
14	Source of Information:		
	a. Impersonal Cosmopolite	0.067 NS	0.643
	b. Personal Cosmopolite	-0.037 NS	0.799
	c. Personal Localite	-0.009 NS	0.951
15.	Social Participation	0.218 NS	0.128

$* P < 0.05$
$** P < 0.01$

Table 3. Correlation between application of fertilizers (Y_2), Micro-nutrient (Y3), Pesticides (Y4), Plant Growth Regulator(Y5) and independent variables

X	Variables	(n=50)							
		Y_2		Y_3		Y_4		Y_5	
		Pearson's Correlation Coefficient (*r* value)	*P* value	Pearson's Correlation Coefficient (*r* Value)	*P* value	Pearson's Correlation Coefficient (*r* value)	*P* value	Pearson's Correlation Coefficient (*r* value)	*P* value
1.	Age	0.118 NS	0.414	0.199 NS	0.165	0.019 NS	0.898	-0.185 NS	0.198
2.	Caste	0.128 NS	0.376	-0.05 NS	0.731	0.062 NS	0.669	0.163 NS	0.257
3.	Occupation	0.01 NS	0.945	-0.194 NS	0.177	0.003 NS	0.985	0.325*	0.021
4.	Education	0.063 NS	0.663	-0.146 NS	0.313	-0.299*	0.035	-0.063 NS	0.664
5.	Land	0.091 NS	0.529	0.035 NS	0.81	0.229 NS	0.11	0.264 NS	0.064
6.	Family: Type	0.006 NS	0.968	-0.001 NS	0.993	-0.109 NS	0.452	-0.136 NS	0.348
	Size of Family	0.005 NS	0.972	-0.245 NS	0.087	0.057 NS	0.696	-0.176 NS	0.221
7.	House	-0.008 NS	0.956	0.186 NS	0.196	0.053 NS	0.713	0.001 NS	0.997
8.	Farm Power	-0.267 NS	0.061	0.494**	0	0.025 NS	0.864	0.310*	0.028
9.	Maternal possession	-0.122 NS	0.398	-0.079 NS	0.587	-0.191 NS	0.184	0.104 NS	0.471
10.	Grading	-0.211 NS	0.141	0.309*	0.029	-0.141 NS	0.329	-0.018 NS	0.903
11.	Technology Adoption:								
	Radio	-0.039 NS	0.785	-0.243 NS	0.089	-0.156 NS	0.279	0.001 NS	0.993
	Television	0.143 NS	0.321	-0.21 NS	0.143	0.171 NS	0.235	-0.136 NS	0.347
	Smart Phone	-0.091 NS	0.532	0.073 NS	0.614	0.123 NS	0.394	0.072 NS	0.62
	Two-Wheeler	-0.004 NS	0.981	-0.137 NS	0.342	-0.173 NS	0.229	-0.072 NS	0.618
	Car	0.00	0.00	0.00 NS	0.00	0.00	0.00	0.00	0.00
12.	Irrigation	0.237 NS	0.097	0.057 NS	0.695	-0.058 NS	0.689	0.131 NS	0.363
13.	Farm Mechanization	0.213 NS	0.137	-0.017 NS	0.908	-0.289*	0.042	-0.166 NS	0.25
14.	Source of Information:								
	a. Impersonal Cosmopolite	0.079 NS	0.585	0.17 NS	0.237	0.076 NS	0.599	-0.094 NS	0.518
	b. Personal Cosmopolite	-0.139 NS	0.336	-0.056 NS	0.7	-0.084 NS	0.563	0.105 NS	0.468
	c. Personal Localite	-0.239 NS	0.094	0.16 NS	0.268	-0.068 NS	0.638	0.281*	0.048
15.	Social Participation	0.066 NS	0.647	0.106 NS	0.464	-0.117 NS	0.419	0.067 NS	0.646

** P < 0.05*

*** P < 0.01*

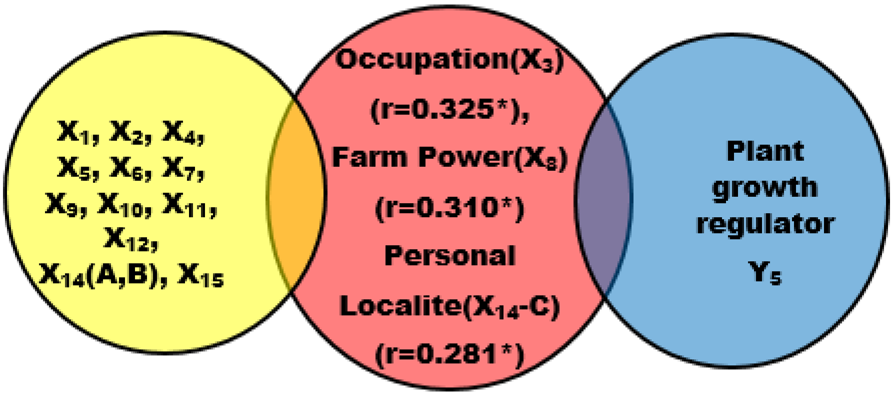

Fig. 5. Coefficient of correlation (*r* value) between application of Plant growth regulators (Y_5) and independent variables (X_1 to X_{15})

However, there is a negative and non-significant link found between the application of organic manures and caste, occupation, education, land holding, family type, farm power, grading, technology adoption of radio, personal cosmopolite, and personal localite.

It is depicted that the application of fertilizers was positively and non-significantly correlated with age, caste, occupation, education, land, family type, family size, television in the adoption of technology, irrigation, farm mechanization, impersonal cosmopolite in the source of information, and social participation. In contrast, there was a negative and non-significant link between the application of fertilizers and the following factors: house, farm power, maternal possession, grading, radio, smartphone, two-wheeler in terms of technology adoption, personal cosmopolite, and personal localite in terms of information source.

It is depicted from Fig. 3 that the application of micronutrients has the most significant correlation coefficient with the independent variable of farm power. Grading's independent variable and the application of micronutrients are significantly correlated. The application of micronutrients was positively and non-significantly correlated with independent variables such as age, land, house, farm power, grading, adoption of smartphones in technology, irrigation, impersonal cosmopolite, personal localite, and social involvement. In contrast, the application of micronutrients was negatively and non-significantly correlated with caste, occupation, education, family type, size, mother possession, radio, television, two-wheeler in technology adoption, agricultural mechanisation, and personal cosmopolite.

Fig. 4 it is obvious that the independent variables of farm mechanisation and education have a considerable impact on pesticide use (Y4). The usage of pesticides was positively and non-significantly correlated with independent factors such as age, caste, occupation, land, family size, house, farm power, television, and smart phone in terms of technological adoption and impersonal, cosmopolitan information sources. In contrast, there was a negative and non-significant link found between the use of pesticides and factors such as education, family type, maternal possession, grading, adoption of radio and two-wheelers, irrigation, agricultural mechanisation, personal cosmopolite, and personal localite as information sources.

Fig. 5, it is clear from the information source that the independent variables of employment, farm output, and personal location significantly correlate with the use of plant growth regulators ('Y5'). The use of plant growth regulators was positively and non-significantly correlated with independent variables such as caste, occupation, land, house, farm power, maternal possession, irrigation, personal cosmopolites, personal localites in source of information, and social participation. In contrast, the following independent variables affect the adoption of technology: television, two-wheelers, age, education, family size, type, and status; agricultural mechanisation; and impersonal, cosmopolitan information sources.

3.1 Discussion

According to this study, brinjal farmers utilize both inorganic chemicals and organic manures to prevent most pests and diseases. However, the majority of farmers exceed the recommended chemical usage, as indicated in Table 1. That collected data on chemical use patterns from locals and dealers in local input shops. Unfortunately, both acute and long-term human health are impacted by this practice. “The knowledge gained will provide a wide perspective on the steps required in conducting research. As a result, research can be organised with a calculated risk, taking into consideration future difficulties. For the current study, a thorough literature review was conducted, and numerous relevant concepts were pooled to determine the dimensions. The findings of the result of chemical handling practices followed by farmers similar to [10-16].

4. CONCLUSION

Fertilizer consumption is high in the Union Territory of Puducherry, compared to other Indian states and union territories. Chemicals used in agricultural and horticultural crops include fertilizers, pesticides, plant growth regulators, and micronutrients. Most chemicals, including fertilizers, pesticides, plant growth regulators, and micronutrients, are recommended by shop dealers. However, farmers often lack awareness of the recommended doses and proper chemical handling practices. The optimization of brinjal crop yield in Puducherry, is based on a balanced chemical application strategy that combines scientific knowledge with practical field management techniques. Continuous research, extension services, and farmers’ education are all required to promote sustainable agricultural practices and ensure the long-term viability of brinjal cultivation in the region.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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