

**PROFITABILITY OF ORGANIC
AGRICULTURE IN INDIA – META ANALYSIS**



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BANGALORE**

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**PROFITABILITY OF ORGANIC
AGRICULTURE IN INDIA – META ANALYSIS**

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CERTIFICATE

This is to certify that the thesis entitled “Profitability of Organic Agriculture in India – Meta Analysis” submitted in partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agricultural Statistics to the University of Agricultural Sciences, Bangalore is a record of *bona fide* research work carried out by Mr. SURAJ SHIVALINGAPPA CHINIVAL, PAMB 0190, during the period of his study in this University, under my guidance and supervision. The thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Place: Bengaluru

Month & Year: December, 2022


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*Affectionately
Dedicated to
My Parents, Family,
Friends
and my Guide*

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(SURAJ SHIVALINGAPPA CHINIVAL)

Profitability of Organic Agriculture in India – Meta Analysis



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INTRODUCTION

- Organic agriculture is a farming method that promotes the health of soils, ecosystems, and people. It is based on biological processes, biodiversity, and cycles that are tailored to local conditions, rather than the use of harmful inputs
- Organic farming is therefore significant because it is a holistic production management method that supports and improves agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity.
- Several studies have demonstrated that organic farming practices can offer better yields than conventional approaches. Significant differences in soil health indicators, such as nitrogen mineralization potential and microbial richness and diversity, may also be detected in organic farms.
- Meta-analysis is a quantitative approach for systematically combining results of previous research to arrive at conclusions.

OBJECTIVE

To estimate the profitability of organic agriculture in India through meta-analysis.

MATERIAL AND METHODS

Study Strategy	Literature were located online through Google Search, Krishi Kosha, ICAR-Krishi portal with Keywords "Profitability", "Economics", "Comparison", "Organic", "Conventional"
Selection Criteria	<p>Inclusion Criteria</p> <ul style="list-style-type: none"> Separate net returns should be available for both Organic and Inorganic At least sample size should be available for both Organic and Inorganic <p>Exclusion Criteria</p> <ul style="list-style-type: none"> Studies conducted outside of India are excluded. Studies not involving agricultural crops are excluded
Data Extraction	Information such as year of publication, first author, state, total no of samples/sample size, Mean income were extracted from the selected articles.
Statistical Analysis	The Meta Analysis was conducted using the STATA software
Data Interpretation	Based on estimators provided by Fixed effects Model, Random effect model, Heterogeneity statistic, Forest plot, Funnel plot and Cumulative Meta-Analysis

50 articles were located from different sources

A total of 24 articles were excluded from the study, out of which

- ❖ 14 articles were rejected as they were not conducted in India.
- ❖ 6 articles were excluded because they did not specifically provide distinct estimates for organic and inorganic materials,
- ❖ 4 articles were rejected as they were not based on Agricultural crops

26 articles were selected based on inclusion/exclusion criteria

Statistical Analysis



The Meta and Metacum packages were installed in STATA software for performing Meta-Analysis

Source of Location	Number of Studies Located	Method	Estimate	P value
Google Search	31	Fixed Effect	3119.97*	0.00
Krishi Kosha	13	Random Effect	3846.11*	0.00
KRISHI Portal	06	Heterogeneity Statistic	4200.00*	0.00
TOTAL	50			

* Significant

Sl.no	Author	Year	Crop	State	Org. SS	Mean or g income	SD	Inor g. ss	Mean inorg income	SD
1	P. Srikrishna Sudheer	2013	Paddy	Andhra Pradesh	150	3482.4	905.61	100	2192	656.69
2	P. Srikrishna Sudheer	2013	Red Gram	Andhra Pradesh	100	2428.4	745.35	50	1626.8	672.21
3	P. Srikrishna Sudheer	2013	Groundnut	Andhra Pradesh	100	3638	832.66	50	1476.4	548.21
4	Durgesh Yadav	2017	Tomato	Madhya Pradesh	25	25085.2	547.11	25	11286	761.11
5	M.Mohan kumar et al	2017	Ragi	Karnataka	45	3388.73	874.62	45	2573.62	751.77
6	M.Mohan kumar et al	2017	Maize	Karnataka	45	11136.88	907.51	45	4614.81	676.65
7	Dr. D. Kumara charyalu et al	2010	Paddy	Punjab	15	17828	901.65	15	20897	815.96
8	Dr. D. Kumara charyalu et al	2010	Wheat	Punjab	15	21208	903.35	15	18319	862.36
9	Dr. D. Kumara charyalu et al	2010	Cotton	Punjab	15	17673	958.64	15	19608	737.51
10	Dr. D. Kumara charyalu et al	2010	Paddy	Uttar Pradesh	15	11488	926.13	15	17190	787.27
11	Dr. D. Kumara charyalu et al	2010	Sugarcane	Uttar Pradesh	15	30961	791.73	15	26054	532.54
12	Dr. D. Kumara charyalu et al	2010	Sugarcane	Maharashtra	15	38854	791.7	15	28680	711.13
13	Dr. D. Kumara charyalu et al	2010	Cotton	Gujarat	15	34299	691.58	15	27112	684.99
14	Karyashree H.V.	2021	Paddy	Karnataka	60	14174.2	754.22	60	8854.4	866.56
15	Sanap Dattaray et al	2008	Cotton	Maharashtra	60	10136.4	1056.53	60	7567.5	478.6
16	Sanap Dattaray et al	2008	Soyabean	Maharashtra	60	9260.844	1063.45	60	6628.43	1064.8
17	Shakthi Singh	2018	Wheat	Punjab	70	51700	642.57	54	39917	829.46
18	Dr.M.S. Deshmukh et al	2019	Jowar	Maharashtra	250	-5542	755.86	150	-12048	682.91
19	Dr.M.S. Deshmukh et al	2019	Turneric	Maharashtra	250	134888.1	668.15	150	142980	781.13
20	R.D. Shetle et al	2016	Tomato	Karnataka	48	86635.48	810.81	48	75770.6	503.05
21	M Shivashankar et al	2014	Sugarcane	Karnataka	60	36353.9	739.28	60	27028.1	768.9
22	V.R. Naik et al	2012	Chilli	Karnataka	30	18227	526.34	30	7984	774.83
23	A.G. Tripathi	2010	Cotton	Andhra Pradesh	50	7753.45	617.04	50	4371.83	692.33
24	A.G. Tripathi	2010	Pigeon Pea	Andhra Pradesh	50	9878.5	1056.58	50	8001.57	510.77
25	A.G. Tripathi	2010	Mung	Andhra Pradesh	50	7028.84	830.89	50	5577.51	886.64
26	A.G. Tripathi	2010	Wheat	Andhra Pradesh	50	7970.56	815.87	50	5701.56	664.55

Tab.1: Summary of the collected Studies

RESULTS AND DISCUSSION

- ❑ Twenty six studies used in meta analysis demonstrated significant heterogeneity leading to the pooled profit (Rs. 3846/acre) organic over inorganic agriculture in India provided by Random Effect Model.
- ❑ The Forest plot provides the estimated profit (Rs.3846/acre) of organic over inorganic agriculture of individual study represented by the size box corresponding to its magnitude, while the confidence interval of the estimator is represented by the arms of the box.
- ❑ The cumulative meta analysis demonstrates the trend of the income (Rs.3846/acre) of organic against inorganic agriculture over the years. This graph depicts that the income was less then pooled estimate in early years and further reduced over years and gradually increased & stabilized later to pooled estimate (Rs.3846/acre).
- ❑ The results are on par with the similar study conducted by David W C et al. (2015) at global scale for financial competitiveness involving 55 crops grown in 14 countries on 5 continents, wherein he reports that organic agriculture was more profitable than conventional agriculture.
- ❑ However, there is scope to continue the meta-analysis with subgroup analysis for exploring difference across crops, regions, different cost of production etc.

SUMMARY

- ❑ We conclude that organic farming generate (Rs. 3846 /acre) more profit than inorganic farming in India.

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KNAPP, S. AND VAN DER HEIJDEN, M.G., 2018, A global meta-analysis of yield stability in organic and conservation agriculture. *Nature communications*, 9(1): 1-9.

REIMER, M., MÖLLER, K. AND HARTMANN, T.E., 2020, Meta-analysis of nutrient budgets in organic farms across Europe. *Org. Agri.*, 10(2): 65-77.

ADVISORY COMMITTEE

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Dr. V. Ramamurthy

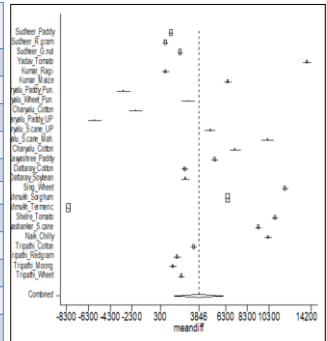


Fig.1 : Forest Plot

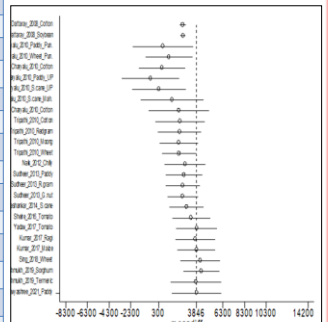


Fig.2 : Cumulative Meta-Analysis

PROFITABILITY OF ORGANIC AGRICULTURE IN INDIA - META ANALYSIS

SURAJ SHIVALINGAPPA CHINIVAL

ABSTRACT

India has a rich history of organic farming and has tremendous potential to establish itself on both the domestic and international markets. Immediate effort must be taken to promote organic farming in order to increase our exports. In this regard, an attempt is made to provide a basic understanding of the benefits and profitability of organic agriculture as compared to inorganic agriculture across the country with this research project through an appropriate statistical model. Data was extracted from the selected 27 studies from the year 2008 to 2021 for the present study. Statistical analyses were carried out with the aid of STATA statistical software version 2.0. The results of meta-analysis over twenty-seven studies demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs.3850/acre) as compared to inorganic agriculture in India. Cumulative meta-analysis demonstrated the trend of the income of organic agriculture, compared to inorganic agriculture, less than pooled estimate in early years and further reduced over years and gradually increased and stabilized later to pooled estimate of Rs.3850/acre. The sub-group analysis results indicated that the mean estimated value for the performance of organic agriculture was highest in the South region (Rs.4332.54/acre) among different regions; in sugarcane (Rs. 8135.57/acre) among different crops; in Karnataka (Rs. 7181.75/acre) among different states; and in 2017 (Rs. 7045.46/acre) among different years. The 20th study, titled Deshmukh's on Turmeric Crop, had a greater impact on the pooled estimate in an influential meta-analysis. It was therefore regarded as an outlier among the chosen studies.

December, 2022

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ಭಾರತದಲ್ಲಿ ಸಾವಯವ ಕೃಷಿಯ ಲಾಭದಾಯಕತೆ - ಮೆಟಾ ವಿಶ್ಲೇಷಣೆ

ಸೂರಜ್ ಶಿವಲಿಂಗಪ್ಪ ಚಿನಿವಾಲ

ಸಾರಾಂಶ

ಭಾರತವು ಸಾವಯವ ಕೃಷಿಯ ಶ್ರೀಮಂತ ಇತಿಹಾಸವನ್ನು ಹೊಂದಿದ್ದು, ರಾಷ್ಟ್ರೀಯ ಮತ್ತು ಅಂತರಾಷ್ಟ್ರೀಯ ಮಾರುಕಟ್ಟೆಗಳಲ್ಲಿ ತನ್ನನ್ನು ತಾನು ಸ್ಥಾಪಿಸಿಕೊಳ್ಳುವ ಪ್ರಚಂಡ ಸಾಮರ್ಥ್ಯವನ್ನು ಹೊಂದಿದೆ. ಸಾವಯವ ಕೃಷಿಯಲ್ಲಿನ ನಮ್ಮ ರಫ್ತನ್ನು ಹೆಚ್ಚಿಸಲು ಶೀಘ್ರಗತಿಯಲ್ಲಿ ಅಗತ್ಯ ಕ್ರಮಗಳನ್ನು ತೆಗೆದುಕೊಳ್ಳಬೇಕು. ಈ ನಿಟ್ಟಿನಲ್ಲಿ, ಸೂಕ್ತವಾದ ಮಾದರಿಗಳನ್ನು ಬಳಸಿಕೊಂಡು ಈ ಸಂಶೋಧನಾ ಯೋಜನೆಯ ಮೂಲಕ ದೇಶಾದ್ಯಂತ ಅಜೈವಿಕ ಕೃಷಿಗೆ ಹೋಲಿಸಿದರೆ ಸಾವಯವ ಕೃಷಿಯ ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಲಾಭದಾಯಕತೆಯ ಬಗ್ಗೆ ಮೂಲಭೂತ ತಿಳುವಳಿಕೆಯನ್ನು ನೀಡಲು ಪ್ರಯತ್ನಿಸಲಾಗಿದೆ. ಅಧ್ಯಯನಕ್ಕಾಗಿ ೨೦೦೮ ರಿಂದ ೨೦೨೧ ರವರೆಗಿನ ಆಯ್ದು ೨೭ ಅಧ್ಯಯನಗಳಿಂದ ದತ್ತಾಂಶಗಳನ್ನು ಹೊರತೆಗೆಯಲಾಗಿದೆ. STATA ಸ್ಟಾಟಿಸ್ಟಿಕಲ್ ಸಾಫ್ಟ್‌ವೇರ್ ಆವೃತ್ತಿ ೨.೦ ರ ಸಹಾಯದಿಂದ ದತ್ತಾಂಶಗಳ ವಿಶ್ಲೇಷಣೆಯನ್ನು ಕೈಗೊಳ್ಳಲಾಯಿತು. ಬಳಸಿದ ಇಪ್ಪತ್ತೇಳು ಅಧ್ಯಯನಗಳ ಮೆಟಾ-ವಿಶ್ಲೇಷಣೆಯ ಫಲಿತಾಂಶಗಳು ಭಾರತದಲ್ಲಿನ ಅಜೈವಿಕ ಕೃಷಿಗೆ ಹೋಲಿಸಿದರೆ ಸಾವಯವ ಕೃಷಿಯ (ರೂ.೩೮೫೦/ಎಕರೆ) ಒಟ್ಟುಗೂಡಿದ ಲಾಭಕ್ಕೆ ಕಾರಣವಾಗುವ ಗಮನಾರ್ಹ ವೈವಿಧ್ಯತೆಯನ್ನು ಪ್ರದರ್ಶಿಸಿದವು. ಸಂಚಿತ ಮೆಟಾ-ವಿಶ್ಲೇಷಣೆಯಲ್ಲಿ ಅಜೈವಿಕ ಕೃಷಿಗೆ ಹೋಲಿಸಿದರೆ ಸಾವಯವ ಕೃಷಿಯ ಆದಾಯದ ಪ್ರವೃತ್ತಿಯನ್ನು ಪ್ರದರ್ಶಿಸಲಾಯಿತು, ಆರಂಭಿಕ ವರ್ಷಗಳಲ್ಲಿ ಕಡಿಮೆ ಅಂದಾಜು ಮೊತ್ತವನ್ನು ಒಟ್ಟುಗೂಡಿಸಲಾಯಿತು ಮತ್ತು ವರ್ಷಗಳಲ್ಲಿ ಮತ್ತಷ್ಟು ಕಡಿಮೆಯಾಯಿತು ಮತ್ತು ಕ್ರಮೇಣ ಹೆಚ್ಚಾಯಿತು ಮತ್ತು ಸ್ಥಿರಗೊಳಿಸಲಾಯಿತು. ಉಪ-ಗುಂಪಿನ ವಿಶ್ಲೇಷಣೆಯ ಫಲಿತಾಂಶಗಳು ಸಾವಯವ ಕೃಷಿಯ ಕಾರ್ಯಕ್ಷಮತೆಯ ಸರಾಸರಿ ಅಂದಾಜು ಮೌಲ್ಯವು ವಿವಿಧ ಪ್ರದೇಶಗಳಲ್ಲಿ ದಕ್ಷಿಣ ಪ್ರದೇಶದಲ್ಲಿ (ರೂ.೪೩೩೨.೫೪/ಎಕರೆ); ವಿವಿಧ ಬೆಳೆಗಳಲ್ಲಿ ಕಬ್ಬಿನಲ್ಲಿ (ರೂ. ೮೧೩೫.೫೭/ಎಕರೆ); ವಿವಿಧ ರಾಜ್ಯಗಳಲ್ಲಿ ಕರ್ನಾಟಕದಲ್ಲಿ (ರೂ. ೭೧೮೧.೭೫೭/ಎಕರೆ); ಮತ್ತು ವಿವಿಧ ವರ್ಷಗಳಲ್ಲಿ ೨೦೧೭ ರಲ್ಲಿ (ರೂ. ೭೦೪೫.೪೬/ಎಕರೆ) ಅತ್ಯಧಿಕವಾಗಿದೆ ಎಂದು ಸೂಚಿಸಿತು. ೨೦ನೇ ಅಧ್ಯಯನವಾದ ದೇಶಮುಖರ ಅರಿಶಿನ ಬೆಳೆ ಎಂಬ ಶೀರ್ಷಿಕೆಯು ಪ್ರಭಾವಶಾಲಿ ಮೆಟಾ-ವಿಶ್ಲೇಷಣೆಯಲ್ಲಿ ಸಂಗ್ರಹವಾದ ಅಂದಾಜಿನ ಮೇಲೆ ಹೆಚ್ಚಿನ ಪ್ರಭಾವ ಬೀರಿದೆ. ಆದ್ದರಿಂದ ಆಯ್ಕೆಮಾಡಿದ ಅಧ್ಯಯನಗಳಲ್ಲಿ ಇದು ಅಸಂಗತತೆ ಎಂದು ಪರಿಗಣಿಸಲಾಗಿದೆ.

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ಕೃ. ವಿ. ವಿ., ಜಿ.ಕೆ.ವಿ.ಕೆ, ಬೆಂಗಳೂರು-೬೫

ಮಲ್ಲಿಕಾರ್ಜುನ, ಬಿ. ಹಂಜಿ.
ಪ್ರಮುಖ ಸಲಹೆಗಾರರು

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LIST OF ABBREVIATIONS

Sl. No.	Abbreviation	Expansion
1.	APEDA	Agricultural and Processed Food Products Export Development Authority
2.	FAO	Food and Agriculture Organization
3.	HLPE	High-Level Panel of Experts on Food Security
4.	IAASTDC	International Assessment of Agricultural Knowledge, Science, and Technology for Development
5.	IFOAM	International Federation of Organic Agriculture Movements
6.	IFS	Inorganic farming System
7.	KSOCA	Karnataka State Organic Certification Agency
8.	MIDH	Mission for Integrated Development of Horticulture
9.	MoAFW	Ministry of Agriculture and Farmers' Welfare
10.	MOVCDNER	Mission Organic Value Chain Development for North East Region
11.	NAB	National Accreditation Body
12.	NCOF	National Centre of Organic Farming
13.	NPOF	National Project of Organic Farming
14.	NPOP	National Programme for Organic Production
15.	NSOP	National standards for organic production
16.	OFS	Organic farming System
17.	PKVY	Paramparagat Krishi Vikas Yojana
18.	RKVY	Rashtriya Krishi Vikas Yojana
19.	WHO	World Health Organization

INTRODUCTION

I INTRODUCTION

Globally, in depth analyses like the United Nations-led International Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD), 2008, and the High-Level Panel of Experts on Food Security and Nutrition (HLPE), 2019, have expressed worries regarding the current chemical and input intensive agricultural models. They have emphasised that continuing with agriculture as usual is no longer an option. Only 60 harvesting years were left, according to the Food and Agriculture Organization (FAO) of the United Nations (2015). This was due to soil degradation. All of these analyses emphasised the immediate requirement for significant reform of food systems and identify suitable agro-ecology as the answer. In order to transition to sustainable food systems that benefit people, the environment, and livelihoods, agro-ecology, or the application of ecological concepts to agricultural systems and practises, is seen as a comprehensive answer. Agro-ecology is the secret to achieving food sovereignty, according to farmer movements all around the world. Additionally, agro-ecology supports a number of the UN Sustainable Development Goals for 2030, including combating hunger, poverty, and inequality; enhancing nutritional options; addressing climate change; and preserving biodiversity.

1.1 Organic agriculture and its principles

Organic agriculture is a farming method that promotes the health of soils, ecosystems, and people. It is based on biological processes, biodiversity, and cycles that are tailored adjusting to local conditions as opposed to using destructive inputs. Organic farming combines science, creativity, and tradition to enhance the environment while also fostering just relationships and a good standard of living for all parties. (Anon, 2008). Organic agriculture is a comprehensive production management method that supports and improves agro-ecosystem health, such as biological cycles, soil biological activity and biodiversity. The use of management techniques is emphasised over the use of off-farm inputs because it is understood that regional conditions call for locally tailored solutions. To accomplish any stated function inside the system, this is done by using biological, mechanical, and agronomic processes rather than manmade materials." (Anon, 1999).

The main principles of organic agriculture are:

- i. Agricultural practises should be modelled after nature. The soil must be viewed as a living system rather than an inert vessel for dumping pollutants,
- ii. Rely mostly on renewable resources to attain and keep soil fertility for maximum production.
- iii. Maintain and preserve wild life and their habitats,
- iv. Instead of relying on inputs, maintain and improve the soil's long-term fertility and biological activity utilising locally accepted cultural, biological, and mechanical techniques,
- v. By paying attention to the management of germplasm on farms, genetic variety can be maintained and conserved.
- vi. Strike a healthy balance between the production of crops and animal husbandry.
- vii. To protect the natural predators of pests and diseases, use integrated disease and pest control techniques.

Inorganic agriculture and its principles

Inorganic agriculture is an agriculture production method which involves the use of manmade items such as pesticides, herbicides, antibiotics, hormones and other chemical which are used to accelerate the rate of growth of crops.

The main principles of inorganic farming are

- (a) manages resource inputs (i.e., fertilizer, irrigation water, amendments, pesticides) uniformly.
- (b) maximize yield, production and profit.
- (c) To achieve food safety and economy.

1.2 Organic agriculture in India

India is deeply attached to organic agriculture. The earliest known scientific method of organic agriculture dates back to the "later Vedic period" of the Vedas, whose central idea is to coexist with nature rather than to exploit it. Indian farmers have long been supported by organic agriculture. It may be claimed that the idea of organic agriculture is very much indigenous to our region and that our farmers are organic by default. In India, organic agriculture used to be more than simply a farming technique; it was a way of life and a tradition that had influenced its people's culture, way of thinking, style of living, and way of doing business for generations.

India is first in terms of the overall number of producers and ranks eighth in the world in relation to organic agricultural land. In India, organic agriculture is still in its infancy. By March 2020, organic agriculture was practised on over 2.78 million hectares of cropland, according to the Union Ministry of Agriculture and Farmers' Welfare. This equates to 2 per cent of the nation's 140.1 million hectares of net planted land. Several states have taken the lead in expanding coverage because a sizable share of organic agriculture is concentrated in a few numbers of them. With 0.76 million hectares of organic agricultural space, Madhya Pradesh ranks first in the list and accounts for more than 27 per cent of all organic farming space in India. The three top states have more than half of all organic agricultural acreage, Madhya Pradesh, Rajasthan, and Maharashtra. Nearly 80 per cent of the total land used for organic agriculture is in the top ten states. The only Indian state to go entirely organic so far is Sikkim. Only a small percentage of the net planted area in the majority of states is used for organic farming. Only about 4.9, 2.0, and 1.6 per cent of the net sown area in the top three states with the most organic land is Madhya Pradesh, Rajasthan, and Maharashtra respectively (Anon, 2020a)

Only about 12 states, including Gujarat, Telangana, Karnataka, Odisha, Tamil Nadu, Bihar, Sikkim, Uttarakhand, Uttar Pradesh, Rajasthan and Madhya Pradesh currently have their own state-level organic certification bodies that have been accredited by the Agricultural and Processed Food Products Export Development Authority (APEDA). Some states have created or are in the process of creating organic brands,

including MP Organic, Organic Rajasthan, Nasik Organic, Bastar Naturals, Kerala Naturals, Jaivik Jharkhand, Naga Organic, Organic Arunachal, Organic Manipur, Tripura Organic, and Five Rivers by Punjab. However, the organic farming movement in India is still more of a niche than a widespread movement. Only 2 per cent of India's net sown land is organically farmed, and only 1.3 per cent of farmers there are registered for organic farming.

1.3 Efforts of Government of India to promote organic agriculture

The Indian government has pushed organic agriculture mostly through an export-focused strategy supported by a third-party certification system. This was an element of the National Programme for Organic Production (NPOP), which the Agricultural and Processed Food Products Export Development Authority (APEDA) of the Ministry of Commerce and Industry, Government of India, initiated in 2001. The former Ministry of Agriculture produced India's first organic farming policy in 2005. Only in 2014–15 did the Ministry of Agriculture and Farmers' Welfare launch the National Mission for Sustainable Agriculture, which aimed to encourage organic farming (MoAFW). Among the initiatives and programmes relevant to organic farming were the National Centre of Organic Farming (NCOF), National Project on Organic Farming (NPOF), Paramparagat Krishi Vikas Yojana (PKVY), Mission Organic Value Chain Development for North East Region (MOVCDNER), and a soil health management programme. The flagship programmes among these, although having minimal budgets, are PKVY and MOVCDNER. States may also decide to use a small fraction of funding from government initiatives like the Rashtriya Krishi Vikas Yojana (RKVY) and the Mission for Integrated Development of Horticulture (MIDH) to promote organic farming in their specific regions.

One of India's NAB (National Accreditation Body) Accredited Certification Bodies is the KSOCA (Karnataka State Organic Certification Agency). In line with the NSOP, which is controlled by APEDA, the Indian government, it certifies organic products. The standard of organic food must be guaranteed by independent certification. The NAB has granted the KSOCA accreditation to perform the Organic Certification due to the product's conformity. The National Benchmark for Organic Product, which is the standard for

Organic Certification, has been developed, claims the Government of India (NSOP). Items with certification as organic can be sold on both domestic and international markets, with the majority going to countries in Europe. If products are certified, customers will believe in their integrity and purchase organic goods. (Anon, 2020b).

1.5 Problem statement

In order to increase food production, the nation adopted the input and chemical intensive Green Revolution model in the 1960s. The creation of novel seed varieties, increased use of synthetic fertilisers, and irrigation for boosting food production were the main areas of concentration. Although this strategy increased food production, it did not pass the sustainability test. It is clear that there are problems, such as overuse and deterioration of natural resources including land and water, loss of biodiversity, and problems with human and animal health. The future of the current chemical and input intensive approach has received major criticism from the sustainability of food production systems in India, which has been linked to declines in soil health, productivity losses, soil infertility, desertification, reduced agro-diversity, pesticide pollution, and emerging pest-resistance. Further, when compared to inorganic items of the same commodity, organic products often command a significant premium in industrialised countries at the retail level, ranging from 10 to 50 per cent (and in some circumstances as high as 100-200%). As a result, organic farming goods somewhat countered declining food prices and the end of government subsidies for agricultural inputs. They could also assist in making up for the loss of preferential trade agreements.

However, India has a long history of organic farming, has enormous potential to establish itself on both the national and worldwide markets, and immediate action must be taken to promote organic farming in order to boost exports. But there is little research and details regarding economics of producing and marketing organic produce, or OFS (Organic Farming System) in comparison to inorganic produce, or IFS (Inorganic Farming System) generally.

One study can only provide reliable information for one place or time period. It is unable to reach clear conclusions on a specific topic of interest and instead presents a

variety of answers to numerous problems in a variety of settings/epochs, or both. It is critical to comprehend how stable a given study's findings are in diverse settings and to provide trustworthy results for a bigger population, either in terms of time or space or both. When a single study does not address the desired issue, estimates from two or more studies might be pooled and carefully assessed to produce more accurate results. by combining the findings of numerous studies using statistical analysis, one may analyse the consistency of the overall summary conclusion across investigations.

In this sense, meta-analysis is a statistical method that goes beyond the constraints imposed by the size or scope of a single study. Analysis of analyses is considered as meta-analysis. It brings together the findings from multiple relevant studies and provides more trustworthy information regarding treatment outcomes. "The statistical examination of a group of analytic outcomes for the goal of integrating their conclusions," is what meta-analysis is. The outcomes of published studies from the literature are integrated to produce concise findings of interest. To avoid the issues with basic pooling analysis, meta-analysis weights individual research results while taking into considering the characteristics of each study. Since it is relying upon additional data, meta-analysis of the prevalence and risk factors of mastitis in cattle on farms has numerous advantages, including improved accuracy in effect estimation and the creation of fresh research hypotheses. Additionally, it effectively increases statistical power, or the likelihood of identifying a real effect as statistically significant if it is present for average estimates. It evaluates whether additional research is required to fully explore a problem.

In fact, organic agriculture, according to one school of thinking, it provides high-quality food while also improving an individual's health and the soil environment. As a result, the majority of state governments support organic farming. According to the second school of thinking, In organic agriculture, crop yields would be dramatically reduced in the early years, and farmers will not be able to earn remunerative rates for their produce. As a result, most farmers are conflicted about adopting organic farming as a regular practice. Therefore, an attempt is made to provide a basic understanding about the benefits of organic and inorganic agriculture across the country with a research project work entitled **‘Profitability of organic agriculture in India –Meta Analysis’**.

1.4 Objectives of the study

The broad objective of the present study is to find out the profitability of organic agriculture as compared to inorganic agriculture through an appropriate statistical model. The specific objectives of the study are given below:

- i To estimate the profitability of organic agriculture in India through meta-analysis
- ii To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India

1.6 Significance of the study.

The current study makes an effort to use the statistical method known as meta-analysis. The accuracy of results can be improved through meta-analysis. This also effectively expands the study's size by integrating the data into one big study, which saves decision makers time and effort when they are considering research. The current study makes an attempt in order to combine earlier studies and provide a reliable conclusion about the profitability of organic farming across the country. This may assist farmers in resolving their uncertainty about adopting organic farming as a regular practise and also assist policymakers in making decisions. The evidence-based research may encourage the government to adopt additional measures to promote organic farming, as it is advantageous from an environmental and financial standpoint.

1.7 Limitations of the study

This study is not an exception to the fact that all statistical studies have limitations, which are listed below:

- Data used in this study is only based on annual crops and there is a scope to include plantations crops with appropriate tools to compute annual income for the same.
- The profitability computation across years may be adjusted for inflation to arrive at more appropriate conclusions.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The main purpose of this chapter is to present a conceptual framework relating to develop a statistical model for predicting the outbreak of the disease. Previous studies have given way to future research endeavours. It was felt necessary to get the acquaintance with earlier pertinent studies to develop appropriate research methodology and for a better understanding of the research problem. Keeping in view the objectives of the study, reviews of the literature related to the study are presented below under the following headings:

2.1 Economics of organic and inorganic agriculture in agriculture

2.2 To estimate the profitability of organic agriculture in India through meta-analysis

2.3 To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India.

2.1 Economics of organic and inorganic studies in agriculture

Rahudkar and Phate (1992) described the experiences of organic sugarcane and organic grape growing farmers from Maharashtra. They reported that individual farmers growing sugarcane and grapes marked that the fertility of their soil increased after the use of vermi compost. Besides this, they not only observed the irrigation requirement of these crops reduced by 45 per cent but also the net profits from both organic sugarcane and organic grape farms were seen to be higher.

Kenchaiah and Balasubramanian (1996) conducted a field experiment during Kharif with rice (cv.ASD 18) to study the effect of organics on growth, yield components in Tamil Nadu Agricultural University, Coimbatore. The study indicated that the combined application of farm yard manure + neem cake recorded significantly higher grain yield (6.17 t/ ha) than other treatments (2.01 to 5.33 t/ha) followed by combination of farm yard manure + poultry manure and pressmud (4.89 to 5.33 t/ ha). However, conventional farming treatment gave grain yield of 4.54 t/ha the pest incidence on crop was low and were no significant differences among treatments.

Chavan *et al.* (1997) conducted a field experiment in 1995-1996 with chili (Pusa Jwala) at horticultural farm Marathwada Agricultural University, Parbhani to study the influence of combined application of FYM and urea on chili yield, uptake of nutrients and quality in terms of ascorbic acid. They indicated that the combined application of FYM (75 kg N/ha) and urea (75 kg N/ha) recorded higher yield of grain chilies (6802.60 kg/ha), red chilies (1975.30 kg/ha) and dry matter (834.57 kg/ha) than the nitrogen application through urea (150 kg N/ha) alone where the green chilies (5639.30 kg), and red chilies (1644 kg) and dry matter (626.23 kg/ha).

Hachappalavar and Kunal (2002) attempted to estimate the yield levels and economics of organic farming in Shimoga of Karnataka. The results showed that, the organic farms produce 22 and 18 per cent higher yield of paddy and sugarcane respectively over the inorganic farms. Further, they suggested the farmer to switch over to organic farming which minimizes the environmental degradation. This study also indicated the necessity of large scale multiplication of bio-fertilizer, vermi compost, bio-control agents should be undertaken for distribution to the farmers at reasonable rates by the nongovernmental organizations and private companies.

Sarkar and Mujumdar (2002) studied that effect of FYM, nitrogen and phosphorus on yield and fiber quality of upland cotton in rice fallow land, revealed that application of 10 tons FYM per hectare improved the 2.5 percent span length (1.51%), uniform ratio (1.07%), fiber fineness (1.09%), maturity (0.82%) and ginning outturn (3.51%) along with increase in pooled lint yield by 15.36 per cent over no farm yard manure.

Singh (2003) carried out a study on comparative economics of production of organic produce in Himachal Pradesh. In the study, 100 farmers over three years revealed that total cost of production for maize and wheat per hectare was lower under organic farming system as the yields of organic increased over time. In fact, the net income per hectare from organic farming was found to be 2 to 3 times higher both in case of maize and wheat. This was not only due to good yields but also the net returns earned by the farmers manifold. Despite the increase in yield by 10 to 20 per cent of all the crops, the farmer was able to fetch higher prices by 25 to 61 per cent of his organic produce. The organic

product was sold by under taking a contact with private firm and thus he was able to reduce the marketing cost by 12 to 22 per cent.

Bisoyi *et al.*(2003) in his study pointed out that the results of 1050 field demonstrations come trials conducted under national project on development and use of bio-fertilizer in different parts of India indicate an increase of 4 percent in the yield of plantation crops, 7 per cent in fruit crops, 9 per cent in wheat and sugarcane, 10 per cent in millets and vegetable, 11 per cent in fibre, 13 per cent in rice and pulses, 15 per cent in tobacco, 14 per cent in oil seeds and flower.

Krishna and Ram (2006) studied long term impact of organic and inorganic fertilization on grain yield and quality of rice in Mollisol of Tarai, revealed that maximum yield and uptake of rice were found in 100 per cent NPK + FYM. The continuous cropping without fertilization leads to depletion of organic matter leading to decrease in yield and nutrient uptake as compared to balanced fertilization along with organic manure, which had beneficial effect on organic matter and ultimately increases yield of rice.

Mane (2006) studied economics of production of organic vs. inorganic soybean in Nanded district, study revealed that per ha. production of organic soybean was 22 quintal and inorganic 22.5 quintal the gross return estimated to Rs. 24350 and Rs. 24925 for organic and inorganic respectively. The net profit on cost 'C5 estimated to Rs. 8854.33 and Rs. 8160.36 for organic and inorganic respectively. Per quintal cost estimated to Rs. 704.33 for organic and Rs. 745.09 for inorganic. The input --output ratio was 1.57 and 1.48 for organic and inorganic respectively.

Kshirsagar (2006) studied the organic sugarcane farming in Maharashtra: present performance and future challenges, study revealed that the yield of organic sugarcane crop was lower than inorganic sugarcane crop. The average yield of organic sugarcane crop was 99.97 tons and 95.16 tons per hectare as against 108.86 tons and 101.45 tons per hectare of inorganic sugarcane crop on sample farms in Kolhapur and Jalgaon districts respectively. This indicates, on an average OS farmers realized 6.79 per cent lower yield than IS farmers. Gross value of production from organic sugarcane crop was higher by 4.12

per cent than the gross value of production from inorganic sugarcane crop on sample farms in study district. Profit from organic sugarcane crop at Rs. 79694 per hectare were higher by 15.63 per cent than inorganic sugarcane crop. Comparison of GYP / GCC ratio across the sample type revealed that after investing a rupee in the cultivation of OS crop , the gross return (GYP) were 21.41 per cent higher than IS crop.

Raghuvanshi (2010) reported that the average cost of cultivation of organic paddy was 8,609 Rs/ha whereas in inorganic paddy the average cost of cultivation was 14,678 Rs /ha and organic paddy farmers received on an average 18,369 Rs gross income per hectare whereas inorganic paddy farmers received 22,585 Rs/ha.

Sujatha (2010) reported that the cost of cultivation in the crops grown organically was lesser than the crops grown non organically and the yield was less in organic crops the net income realized was slightly higher in organic crops as the cost of cultivation was less in these crops.

Pornpratansombat *et al.* (2011) indicated that the average yield per rai of organic farms is slightly lower than conventional farms i.e., 3.61 per cent of difference exists.

Kondaguri (2012) reported that net return on organic farm was Rs 21256.70 and was Rs 15643.29 on inorganic farms, the B:C ratio was also higher on organic farms (1.74) compared to inorganic farms (1.49).

2.2 To estimate the profitability of organic agriculture in India through meta-analysis

Kuhberger *et al.* (1998) conducted A meta-analysis of framing effects is presented for risky choice problems which are framed either as gains or as losses. This evaluates the finding that highlighting the positive aspects of formally identical problems does lead to risk aversion and that highlighting their equivalent negative aspects does lead to risk seeking. Based on a data pool of 136 empirical papers that reported framing experiments with nearly 30,000 participants, we calculated 230 effect sizes. Results show that the overall framing effect between conditions is of small to moderate size and that profound differences exist between research designs.

Fourichon *et al.* (2000) conducted meta-analysis of previously published research to examine effect of disease (dystocia, stillbirth, milk fever, retained placenta, abortion, cystic ovaries, ketosis, anoestrus, displaced abomasum, locomotor disorders, and mastitis) reproduction in the dairy cow by using 70 published papers.

Bengtsson *et al.* (2005) used a meta-analysis of literature published before December 2002 to examine the impact of organic farming on species richness and abundance. Organic farming often enhances species richness, with conventional agricultural systems having a 30 per cent higher species richness on average. However, the results varied amongst research, and 16 per cent of them suggested that organic farming had a detrimental influence on species richness. As a result, they categorised the data into distinct organism groups and according to the study's spatial size. Organic farming has the greatest impact in research conducted at the plot scale. When organic and conventional farms were matched based on landscape layout in farm-scale research, the effect was substantial but very diverse. Organisms were 50 per cent more numerous in organic agricultural systems on average, although the findings varied greatly between research and organism groupings. Organic farming was beneficial to birds, predatory insects, soil organisms, and plants, but not to non-predatory insects and pests. Organic farming had a favourable influence on abundance at the plot and field scales, but not for farms in matched environments. Organic farming has been shown to have a favourable influence on species richness and abundance, however the benefits vary between creature groups and environments.

Moyo *et al.* (2005) carried out a meta-analysis of 14 papers between 1984 and 2003 to estimate the magnitude and significance of the weighted summarised effect of vitamin E status on udder health.

Duffield *et al.* (2008) conducted a meta-analysis of the impact of monensin on health and reproductive outcomes from 16 papers in 9500 dairy cattle and concluded that decreases risk of ketosis and mastitis. Dystocia and retained placenta showed heterogeneity across studies, -18- Review of Literature Meta-analysis of prevalence of important infectious diseases of bovines in India so they further analysed the data using random effect

model and heterogeneity across the studies explored by meta-regression and concluded that prolonged treatment with monensin before calving increased the risk of dystocia and retained placenta.

Lean *et al.* (2009) described methods and applications of meta-analysis in animal and veterinary science and suggested that rigorously conducted meta-analyses are useful tool to improve animal health and productivity. They described different methods for combining dichotomous and continuous data and post-hoc methods used to evaluate heterogeneity and publication bias, which include the I² statistic, L' Abbé plots, Galbraith plots, Rosenthal' SN , and influential study analysis. Meta-analytic approaches offer the opportunity to evaluate new hypotheses, and are more valuable compared to any single study contributing to the analysis. These methods will be very useful for new researchers who want to conduct meta-analysis.

Van de wouw *et al.* (2010) examined genetic diversity trends using meta-analytic approaches and a study weight tailored for use with diversity indices. The meta-analysis examined 44 published studies that addressed diversity patterns in released crop varieties in the twentieth century for eight major field crops, with wheat being the most well-represented. The meta-analysis found that, in the long run, there has been no significant loss in the geographical diversity of crop types supplied by plant breeders. When comparing diversity in the 1960s to diversity in the 1950s, a substantial drop of 6% was noticed. Breeders appear to have been able to enhance the diversity of released kinds again after the 1960s and 1970s. As a result, there was no evidence of a steady reduction of the genetic foundation of the varieties provided by breeders. Independent analysis for wheat and the group of other field crops, as well as separate analyses by area, all revealed comparable trends in diversity.

Chen *et al.* (2011) conducted a meta-analysis to study the effect of biotin on milk performance of dairy cattle by using 11 studies. A data of 238 cows were analysed using fixed effects models (12%) with the help of Stata software. It was found that biotin increases dry matter intake and milk production in lactating dairy cows by 0.87 kg/d and 1.66 kg/d, respectively.

Halasa *et al.* (2011) used meta-analysis of 27 studies out of 96 studies to provide a comprehensive assessment of the efficacy of foot and mouth disease (FMD) emergency and concluded that emergency vaccination against FMD provided protection against clinical disease and against FMD infection in cattle, swine and sheep. Vaccinated cattle have lower chance of developing FMD clinical signs as compared to non-vaccinated cattle. No significant publication bias was observed. The results can be used in simulation to assess the economic consequence of FMD emergency vaccination.

Jeffery *et al.* (2011) performed a meta-analysis to assess the association between biochar and agricultural productivity (either yield or above-ground biomass). The results revealed that applying biochar to soils had a tiny but statistically significant effect on crop productivity, with a grand mean increase of 10 per cent. The mean results for each analysis done inside the meta-analysis, on the other hand, encompassed a broad range (from 28% to 39%). The biggest (positive) impacts in soil analyses were observed in acidic (14%) and neutral pH soils (13%) as well as soils with a coarse (10%) or medium texture (13%). This shows that a liming impact and better soil water holding capacity, combined with improved crop nutrient availability, may be two of the key causes for yield enhancement. Biochar treatments at a rate of 100 t ha⁻¹ had the most beneficial results (39%). In terms of agricultural production, chicken litter had the strongest (significant) positive effect (28%) of the biochar feedstocks studied, whereas biosolids had the only statistically significant negative effect (28%).

Cai *et al.* (2014) conducted a systematic review and a meta-analysis approach to evaluate the efficacy of the routine vaccination programme against FMD adopted in China. They used 28 published papers in the meta-analysis and analysis was done according to livestock breeds, breeding models and antibody types. Results of meta-analysis the vaccination programme has been very successful in China with more than 70 per cent of animals protected against serotypes Asia-I and O.

Challinor *et al.* (2014) created a new data set of over 1,700 previously published models to assess the yield consequences of climate change and adaptation. Without adaptation, 2 °C of local warming is predicted to result in aggregate production losses for

wheat, rice, and maize in both temperate and tropical countries. Crop-level adaptations enhance simulated yields by 7–15 percent on average, with wheat and rice adaptations being more successful than maize. The amount of yield losses is bigger in the second half of the century than in the first. Although the consensus on yield declines in the second half of the century is greater in tropical regions than in temperate ones, even modest warming may lower temperate crop yields in many locations. Although interannual variability is less well understood than mean yields, current data show that yield variability is increasing.

Wang *et al.* (2014) conducted a review on the risk factors for avian influenza on poultry farms and further the results from 15 selected studies on risk factors for AI infections on poultry farms were analyzed quantitatively by meta-analysis. They concluded that the main risk factors for AI infection in poultry farms are environmental conditions (open water source infections on nearby farms), keeping other livestock on the same farm and no disinfection of the farm.

Knapp and heijden (2018) conducted a meta-analysis analysing 193 papers based on 2896 comparisons to examine the temporal yield stability of three major cropping systems: organic agriculture, conservation agriculture (no-tillage), and conventional agriculture. Organic agriculture has a substantially poorer temporal stability (15%) per unit yield than conventional agriculture. As a result, while organic farming enhances biodiversity and is more ecologically friendly in general, future efforts should focus on minimising production unpredictability. The research also shows that using green manure and increased fertilisation can help to close the yield stability difference between organic and conventional agriculture. The temporal stability of no-tillage (3%) is not statistically different from that of conventional tillage, demonstrating that switching to no-tillage has no effect on yield stability.

Reimer *et al.* (2020) conducted a meta-analysis on 56 separate studies that provided either farm-gate or soil surface budgets. The analysis revealed a nutrient imbalance, with a general surplus of nitrogen (45 kg N ha⁻¹ year⁻¹ [95 per cent confidence interval (CI) 30, 61]), magnesium (16 kg Mg ha⁻¹ year⁻¹ [9, 40]), and sulphur (45 kg S ha⁻¹ year⁻¹ [29, 118]), a balanced phosphorus budget (0 kg P ha⁻¹ year⁻¹ [2, 2]), and a deficit of potassium (12 kg K

ha1 year [21, 3]). They discovered significant disparities between farms, which might be explained in part by farm type and budgeting strategy. Arable and mixed farms had smaller nitrogen, phosphor, magnesium, and sulphur budgets than dairy/beef farms or even vegetable farms, whereas all farm types except dairy/beef farms had K budget deficits. Furthermore, farm-gate budget studies produced larger budgets than soil surface budgets. Variations between investigated nations were also observed, however coverage and comparability were limited due to variations in analysed farm types and budgeting methods.

2.3 To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India.

Bravo *et al.* (2006) conducted A meta-regression analysis including 167 farm level technical efficiency (TE) studies of developing and developed countries was undertaken. The econometric results suggest that stochastic frontier models generate lower mean TE (MTE) estimates than non-parametric deterministic models, while parametric deterministic frontier models yield lower estimates than the stochastic approach. On average, studies for animal production show a higher MTE than crop farming. The results also suggest that the studies for countries in Western Europe and Oceania present, on average, the highest levels of MTE among all regions after accounting for various methodological features. In contrast, studies for Eastern European countries exhibit the lowest estimate followed by those from Asian, African, Latin American, and North American countries.

Amenumey *et al.* (2009) performed A chronologic, cumulative meta-analysis of fifty-three controlled drainage studies demonstrated that controlled drainage is effective and with a mean effect of 47 per cent. A categorical meta-analysis suggested that soil types, crop types and differences in seasonality affect the effectiveness of controlled drainage to reduce drainage volumes.

Griffith (2009) conducted study on the use of Individual Participant Data (IPD) metaanalysis of observational studies to identify sources of heterogeneity among studies examining mechanical exposure and low back pain (LBP) in workers. They concluded that IPD metaanalysis of observational studies can be used to better understand sources of

heterogeneity as aggregated data meta-analysis is likely sufficient to detect heterogeneity for study-level factors but is not sufficient to identify individual-level effect modifiers

An Van den Putte *et al.* (2010) present a meta-regression analysis (47 European studies, 563 observations) that compares crop yields under conventional tillage (CT), reduced tillage (RT) and no-tillage (NT) techniques. We analysed the possible influence on the relative yield ((RT or NT)/CT) of crop type, tillage depth, crop rotation, climate, CT yield and length of application of RT or NT. Our analysis shows that, while the introduction of conservation tillage in Europe may indeed have some negative effect on yields, these effects can be expected to be limited: the overall average reduction we found was ca. 4.5 per cent. NT reduces crop yield on average with 8.5 per cent. However, RT leads to a reduction in crop yields for maize and winter cereals only. By applying a linear mixed model, the importance of tillage depth and crop type as classification effects could be confirmed. Surprisingly, no-tillage did perform worse under drier climatic conditions. Negative effects such as an increased prevalence of pests and a lower quality of seed placement seem to outweigh possible gains due to increased water availability. On clay and sandy soils, however, this negative effect of no-tillage is counteracted, and all conservation tillage techniques perform better under drier climatic conditions. Another important finding is that, in cereals only rotations, relative yields under conservation tillage tend to decrease with time. Our analysis shows that conservation tillage is certainly a viable option for European agriculture from the viewpoint of agricultural productivity. Potential negative effects on agricultural productivity can be strongly reduced by applying sufficiently deep tillage and using a crop rotation including crops other than cereals.

Broeze *et al.* (2010) described Individual patient data meta-analysis as a promising approach for evidence synthesis in reproductive medicine and stated that although meta-analyses provide summary estimates of the treatment effect or the diagnostic test accuracy, they have limitations like they can only summarize aggregated data and the true variability of the treatment effects cannot be explored to the desired level, because the meta-analyses cannot discriminate between patients with different clinical profiles. On other hand, IPD meta-analyses described as the ‘gold standard’ for data synthesis and are a promising approach that might overcome these limitations. IPD meta-analyses allow treatment effects

and diagnostic accuracy to be estimated at the level of relevant patient subgroups therefore, researchers enables to investigate the effectiveness of treatment in patients with diverse profiles.

Stanley and Doucouliagos (2012) purpose is to introduce novice researchers to the tools of meta-analysis and meta-regression analysis and to summarize the state of the art for existing practitioners. Meta-regression analysis addresses the rising "Tower of Babel" that current economics and business research has become. Meta-analysis is the statistical analysis of previously published, or reported, research findings on a given hypothesis, empirical effect, phenomenon, or policy intervention. It is a systematic review of all the relevant scientific knowledge on a specific subject and is an essential part of the evidence-based practice movement in medicine, education and the social sciences. However, research in economics and business is often fundamentally different from what is found in the sciences and thereby requires different methods for its synthesis—meta-regression analysis. This develops, summarizes, and applies these meta-analytic methods.

Abo-Zaid (2011) conducted Individual patient data meta-analysis of studies on prognostic factor such as patient characteristics (e.g. age, biomarker levels) which are associated with future clinical outcomes in patients with a disease or health state. An empirical study was carried out to compare between IPD and aggregated data approach to assess prognostic factors in breast cancer and showed that IPD approach is preferable over aggregated data, as it allows one to adjust the prognostic factor by other confounding factors, it allowed more studies and more patients to be included. An IPD meta-analysis of 4 studies for age as a prognostic factor for 6 month mortality in traumatic brain injury was carried out by developing 11 IPD meta-analysis models and simulation study was undertaken to examine which model is the best either one-step or two-step method. One-step model accounting for the clustering of patients within studies is the best fitted model as it yielded the lowest bias and the coverage was around 95%.

Bangar (2014) conducted a meta-analysis of prevalence risk factor and of mastitis in various organized dairy farms of India and showed the pooled estimate of prevalence of sub clinical mastitis one on-basis was obtained using 6344cows from 25 studies and was

found to be 46.35 per cent. Meta-analysis for quarter-wise prevalence of subclinical mastitis was carried out using 18,721 udder quarters of dairy cows from 23 studies, and the pooled estimate of prevalence of subclinical mastitis on quarter-basis was found to be 23.25 per cent.

Banger *et al.* (2015) conducted a meta-analysis of prevalence risk factor and of mastitis in various organized dairy farms of India and showed that there is statistically high heterogeneity for the prevalence estimates between published studies.

Djokoto *et al.* (2016) conducted a meta regression where number of studies have examined the effect of study characteristics on mean technical efficiency as the dependent variable. This article departs from these earlier studies by using second-stage inefficiency covariates as key exploratory variables and study characteristics as control variables in a meta-regression. Unlike the vote count method of quantitative review, the parameters of the key variables have desirable properties and enable statistical inferences to be drawn. Additionally, the dependent variable employed is mean technical inefficiency. This is demonstrated using data on technical inefficiency of primary studies in Ghanaian agriculture, fitted to fractional regression models

Krishnamoorthy *et al.* (2017) conducted a meta-analysis of prevalence sub clinical and clinical mastitis, major mastitis pathogens in dairy cattle in India and showed that the pooled estimates for prevalence of sub clinical and clinical mastitis were 41 per cent (95% CI 33- 49%) and 27 per cent, respectively.

Kumar (2017) conducted a meta-analysis of prevalence with respect to important cattle diseases in southern India and showed that there was significant heterogeneity between the 10 studies.

Prema (2018) conducted a meta-analysis of prevalence of Classical swine fever in India and showed heterogeneity across studies was 98 per cent by I2 index (I2 statistics describes the percentage of variation across studies that is due to heterogeneity rather than chance).

Jenkins *et.al* (2019) performed a cumulative meta-analysis on the 46 soy trials identified by the FDA to determine if at any time, since the 1999 FDA final rule that established the soy heart health claim, the soy effect on serum cholesterol lost significance. The cumulative meta-analysis for both total cholesterol and low-density lipoprotein cholesterol demonstrated preservation of the small, but significant, reductions seen both before and during the subsequent 14 years since the health claim was originally approved. For low-density lipoprotein cholesterol, the mean reduction in 1999 was -6.3 mg/dL (95% CI, -8.7 to -3.9 mg/dL; P=0.00001) and remained in the range of -4.2 to -6.7 mg/dL (P=0.0006 to P=0.0002, respectively) in the years after 1999.

Mupepele *et.al* (2020) performed a time-cumulative meta-analysis shows that there was no general benefit of biodiversity at any point in the past besides in early 2015. Time-cumulative meta-analysis can unravel missing robustness of meta-analytical results if conclusions alternate between significant to non-significant summary effect sizes over time.

MATERIAL AND METHODS

III MATERIALS AND METHODS

Based on the views and reviews of various scholars, in this chapter, the methodology employed for the present study to achieve all the objectives of the study are presented below under the following heads:

3.1 Type and plan of meta-analysis

3.1.1 Location and classification of studies from the literature

3.1.2 Selection criteria of studies

3.1.3 Data extraction

3.2. Statistical Methods in Meta-analysis

3.2.1 Meta-analysis master sheet

3.2.2 Meta-analysis plots

3.2.3 Methods for pooling estimates

3.2.4 Additional meta-analysis techniques

3.2.5 Software for statistical analysis

3.1 Type and plan of meta-analysis

3.1.1 Location and classification of studies from the literature: The sources of search for literature in meta-analysis include the published literature, unpublished literature, uncompleted research reports and work in progress. Reliance on only published reports leads to publication bias – the bias resulting from the tendency to publish results that are statistically significant. The literature of meta-analysis can be classified as the papers that deal with methodological and statistical issues, the papers actually carrying out meta-analysis and the review papers.

The systematic review's initial stage was to define the study topic and conduct a literature search. A systematic search was conducted for all reported studies on profitability of organic agriculture published from the year 2008 until 2021. Additionally, data were

collected from unpublished sources like thesis data. This systematic literature review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines. A literature survey was performed systematically to collect relevant literature on the profitability of organic agriculture in India. For these studies, data were extracted from Google Scholars (36) and Krishi Kosh thesis (14).

Using different combinations of keywords like Profitability, Comparison, Economics, Organic agriculture, Inorganic agriculture, farming, conventional, along with Boolean operators [or and not] asterisk* and quotation marks [" "], the initial search was done and located fifty articles for the period 2008–2021, and only peer-reviewed publications were retained for final analysis. The locations of the studies from the various sources are shown in Table 1. Thus, 50 studies in all were chosen, including 14 from the Krishi Kosha thesis and 36 from Google Scholar.

Table 1: Source wise studies located for the study

Name of source	Number of studies selected
Google Scholar	36
Krishi kosha thesis	14
Total	50

3.1.2 Selection criteria of studies

Given a vast quantity of heterogeneous literature, suitable studies have to be selected for a meta-analysis. The inclusion and exclusion criteria relate to quality and to the combinability of organic and inorganic outcome. The first criterion must have the studies need to measure both the explanatory and response variables defining objective of the study and provide an estimate of their relationship. Without this information there is nothing to do with a study meta-analytically.

Each additional criterion that used to define the population of meta-analysis should be written down. Where possible, it should provide examples of studies that are included or excluded by the criterion to help clarify the rule.

(a) Inclusion criteria

The inclusion criteria are the standards that ensure studies are included in meta-analyses if they meet the study objective which are given below:

- Separate net returns should be available for both Organic and Inorganic
- At least sample size should be available for both Organic and Inorganic

(b) Exclusion criteria

The requirements known as exclusion criteria prevent studies from being included in meta-analysis since they did not fulfil the study's objective which are given below:

- Studies conducted outside of India are excluded.
- Studies not involving agricultural crops are excluded

During our literature search, we identified 50 potentially relevant articles written in English, published in journals and thesis were included. Based on inclusion and exclusion criteria, the identified articles were screened for relevance. Studies were included if they meet the inclusion criteria and excluded the studies which do not involving agricultural crops and the studies which were conducted outside India were also excluded. Accordingly, studies chosen based on how well they met the criteria for inclusion are presented in Table2. From the data it indicates that a total of 27 studies, including 23 from Google Scholar and 4 from Krishi Kosha thesis, match the inclusion requirements.

Table 2: Source wise studies selected for the study

Name of source	Number of studies selected
Google Scholar	23
Krishi kosha thesis	04
Total	27

A total of 23 articles were excluded from the study, out of which

- 13 articles were rejected as they were not conducted in India.
- 6 articles were excluded because they did not specifically provide distinct estimates for organic and inorganic materials,
- 4 articles were rejected as they were not based on Agricultural crops

3.1.3 Data extraction

List and details of selected studies for the study are presented in Table 3 and data were extracted from the selected 27 studies. Data on the items viz., Title of the selected study, First author, Year published, State, crop, Name of the Journal,

Author, crop and state wise list and details of selected studies include mean income, sample size and standard deviation of mean income for each study on both organic agriculture and inorganic agriculture are presented in Table 4 and data were extracted based on the Bootstrapping method. It is a method that can be used to find standard deviation and to construct a confidence interval for a statistic when the sample size is given. Data on the items of sample size and standard deviation of both organic and inorganic agriculture were extracted.

3.2. Statistical Methods in Meta-analysis

3.2.1 Meta-analysis master sheet

The first step in meta-analysis is to prepare a master sheet. The first column in the master sheet consists of the list of selected studies according to their chronological order of publication. The second column shows the mean difference between organic and inorganic agriculture, whereas the third column shows the standard error across all studies. To observe the heterogeneity between the studies, these are all necessary. The mean differences (MD) and standard error of MD were computed by using the following formulas:

$$MD = (M1 - M2)$$

Table 3: List and details of selected studies for the study

Sl. No.	Title of study selected	Authors	crop	state	Year of publication	Name of the Journal
1	Economics of major crops grown under organic and inorganic farming in parbhani district of maharashtra	Sanap Dattaray <i>et al</i>	Cotton	Maharashtra	2008	Thesis
2	Economics of major crops grown under organic and inorganic farming in parbhani district of maharashtra	Sanap Dattaray <i>et al</i>	Soyabean	Maharashtra	2008	Thesis
3	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Paddy	Punjab	2010	Bilingual journal of Humanities & Social Sciences
4	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Wheat	Punjab	2010	Bilingual journal of Humanities & Social Sciences
5	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Cotton	Punjab	2010	Bilingual journal of Humanities & Social Sciences
6	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Paddy	Uttar Pradesh	2010	Bilingual journal of Humanities & Social Sciences
7	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Sugarcane	Uttar Pradesh	2010	Bilingual journal of Humanities & Social Sciences
8	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	wheat	Uttar Pradesh	2010	Bilingual journal of Humanities & Social Sciences
9	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Sugarcane	Maharashtra	2010	Bilingual journal of Humanities & Social Sciences

Sl. No.	Title of study selected	Authors	crop	state	Year of publication	Name of the Journal
10	Economics of organic farming over conventional farming in India	D. Kumara charyalu <i>et al</i>	Cotton	Gujarat	2010	Bilingual journal of Humanities & Social Sciences
11	A comparative economics of organic and inorganic farming	A.G. Tripathi	Cotton	Andhra Pradesh	2010	Hind agricultural research and training institute
12	A comparative economics of organic and inorganic farming	A.G. Tripathi	Pigeon Pea	Andhra Pradesh	2010	Hind agricultural research and training institute
13	A comparative economics of organic and inorganic farming	A.G. Tripathi	Mung	Andhra Pradesh	2010	Hind agricultural research and training institute
14	A comparative economics of organic and inorganic farming	A.G. Tripathi	Wheat	Andhra Pradesh	2010	Hind agricultural research and training institute
15	Organic and inorganic cultivation of chilli and its marketing- An economic analysis*	V.R. Naik <i>et al</i>	Chilli	Karnataka	2012	Karnataka Journal of Agricultural Sciences
16	Economics of organic versus chemical farming for three crops in Andhra Pradesh, India	P.Srikrishna Sudheer	Paddy	Andhra Pradesh	2013	Journal of Organic Systems
17	Economics of organic versus chemical farming for three crops in Andhra Pradesh, India	P.Srikrishna Sudheer	Red Gram	Andhra Pradesh	2013	Journal of Organic Systems
18	Economics of organic versus chemical farming for three crops in Andhra Pradesh, India	P.Srikrishna Sudheer	Groundnut	Andhra Pradesh	2013	Journal of Organic Systems
19	Economics of sugarcane cultivation under organic and inorganic farming in Bagalkot district of Karnataka	M Shivashankar <i>et al</i>	Sugarcane	Karnataka	2014	International Journal of Commerce and Business Management

Sl. No.	Title of study selected	Authors	crop	state	Year of publication	Name of the Journal
20	Comparative economics of cost and returns of organic tomato production with inorganic tomato production in Kolar district of Karnataka	R.D. Shelke <i>et al</i>	Tomato	Karnataka	2016	International Research Journal of Agricultural Economics and Statistics
21	Comparitive economics of tomato production under organic and inorganic farming practices in khargone district of Madhya Pradesh	Durgesh Yadav	Tomato	Madhya Pradesh	2017	Thesis
22	Economics of organic farming over conventional farming – A case study in karnataka India	M.Mohan kumar <i>et al</i>	Ragi	Karnataka	2017	International journal of current microbiology and applied sciences
23	Economics of organic farming over conventional farming – A case study in Karnataka, India	M.Mohan kumar <i>et al</i>	Maize	Karnataka	2017	International journal of current microbiology and applied sciences
24	A comparative economic analysis of organic inorganic wheat in punjab	Shakthi Singh	Wheat	Punjab	2018	Journal of agricultural development and policy
25	Economics of organic and inorganic farming in Satara District, Maharashtra	M.S. Deshmukh <i>et al</i>	Jowar	Maharashtra	2019	Indian Journal of Economics and Development
26	Economics of organic and inorganic farming in Satara District, Maharashtra	M.S. Deshmukh <i>et al</i>	Turmeric	Maharashtra	2019	Indian Journal of Economics and Development
27	A comparative Analysis of performance of organic and conventional paddy farmers in Karnataka	Kavyashree H.V.	Paddy	Karnataka	2021	Thesis

Table 4: List and details of selected studies for the study with sample size and standard deviation.

Authors	Crop	State	Organic			Inorganic		
			Sample size	SD	Mean income	Sample size	SD	Mean income
P. Srikrishna Sudheer	Paddy	Andhra Pradesh	150	905.6	3482.4	100	656.6	2192.0
P. Srikrishna Sudheer	Red Gram	Andhra Pradesh	100	745.3	2428.4	50	672.2	1626.8
P. Srikrishna Sudheer	Groundnut	Andhra Pradesh	100	832.6	3638.0	50	548.2	1476.4
Durgesh Yadav	Tomato	Madhya Pradesh	25	547.1	25085.2	25	761.1	11286.0
M. Mohan kumar <i>et al</i>	Ragi	Karnataka	45	874.6	3388.7	45	751.7	2573.6
M. Mohan kumar <i>et al</i>	Maize	Karnataka	45	907.5	11136.8	45	676.6	4614.8
D. Kumara charyalu <i>et al</i>	Paddy	Punjab	15	901.6	17828.0	15	815.9	20897.0
D. Kumara charyalu <i>et al</i>	Wheat	Punjab	15	903.3	21208.0	15	862.3	18319.0
D. Kumara charyalu <i>et al</i>	Cotton	Punjab	15	958.6	17673.0	15	737.5	19608.0
D. Kumara charyalu <i>et al</i>	Paddy	Uttar Pradesh	15	926.1	11488.0	15	787.2	17190.0
D. Kumara charyalu <i>et al</i>	Sugarcane	Uttar Pradesh	15	791.7	30961.0	15	532.5	26054.0
D. Kumara charyalu <i>et al</i>	wheat	Uttar Pradesh	15	963.7	14045.0	15	585.8	10101.0
D. Kumara charyalu <i>et al</i>	Sugarcane	Maharashtra	15	791.7	38854.0	15	711.1	28680.0
D. Kumara charyalu <i>et al</i>	Cotton	Gujarat	15	691.5	34299.0	15	684.9	27112.0
Kavyashree H.V.	Paddy	Karnataka	60	754.2	14174.2	60	866.5	8854.4
Sanap Dattaray <i>et al</i>	Cotton	Maharashtra	60	1056.5	10136.4	60	478.6	7567.5
Sanap Dattaray <i>et al</i>	Soyabean	Maharashtra	60	1063.4	9260.8	60	1064.8	6628.4
Shakthi Singh	Wheat	Punjab	70	642.5	51700.0	54	829.4	39917.0
M.S. Deshmukh <i>et al</i>	Jowar	Maharashtra	250	755.8	-5542.0	150	682.9	-12048.0
M.S. Deshmukh <i>et al</i>	Turmeric	Maharashtra	250	668.1	134888.1	150	781.1	142980.4
R.D. Shelke <i>et al</i>	Tomato	Karnataka	48	810.8	86635.4	48	503.0	75770.6
M Shivashankar <i>et al</i>	Sugarcane	Karnataka	60	739.2	36353.9	60	768.9	27028.1
V.R. Naik <i>et al</i>	Chilli	Karnataka	30	526.3	18227.0	30	774.8	7984.0
A.G. Tripathi	Cotton	Andhra Pradesh	50	617.0	7753.4	50	692.3	4371.8
A.G. Tripathi	Pigeon Pea	Andhra Pradesh	50	1056.5	9878.5	50	510.7	8001.5
A.G. Tripathi	Mung	Andhra Pradesh	50	830.8	7028.8	50	886.6	5577.2
A.G. Tripathi	Wheat	Andhra Pradesh	50	815.8	7970.5	50	664.5	5701.5

MD=mean income difference

M1=mean income of organic agriculture

M2= mean income of inorganic agriculture

$$SE(MD) = \sqrt{\frac{SD_1^2}{n_1} + \frac{SD_2^2}{n_2}}$$

SE=standard error

SD1 = Standard deviation of organic agriculture

SD2 = Standard deviation of inorganic agriculture

N1=number of samples in organic agriculture

N2= number of samples in inorganic agriculture

3.2.2 Meta-analysis plots

In more complex situations to understand heterogeneity and its sources, several graphs and diagrams such as Forest plot, Funnel plot, etc have been established to use in meta-analysis. The meta-analysis is graphically represented as a forest plot, where it shows the total estimate of the studies as well as the estimate values for each study with the lowest and upper estimates. A funnel plot is typically created to examine publication bias in the study.

3.2.3 Methods for pooling estimates

The fixed effects model meta-analysis and random effects model meta-analysis are two major groups of meta-analytical procedures used in pooling estimates from different studies.

The principle that simply pooling the data from different studies and treating them as one large study would fail to preserve the randomization and introduce bias and confounding. The results from small studies are more subjective to the play of chance and should therefore be given less weight. Hence, the methods used for meta-analysis employ a weighted average of the results in which the larger studies generally have more influence than the smaller ones. Selection of a meta-analysis method for a particular analysis depends

on the type of primary studies, choice of summary statistics, observed heterogeneity, the known limitations of the computational methods and fixed effects versus random effects model.

Fixed effect Model

Fixed effect model is used to pool binary, continuous and correlation data. This approach has wide applicability since it can be used to combine any estimate that has standard error available. The estimates are combined to give a pooled estimate (denoted by θ) by calculating weighted average of the estimates from the individual studies as follows.

$$\theta_{IV} = \frac{\sum w_i \theta_i}{\sum w_i}$$

Where the weights w_i are calculated as,

$$w_i = \frac{1}{SE(\theta_i)^2}$$

That is, the weight for the i th study is equal to its precision of the estimate.

The standard error of θ is given by,

$$SE(\theta_{IV}) = \frac{1}{\sqrt{\sum w_i}}$$

The heterogeneity statistic (denoted by Q_w) is given by,

$$Q_w = \sum w_i (\theta_i - \theta_{IV})^2$$

The Q_w follows chi-square distribution with $(k-1)$ degrees of freedom, where k is the number of studies included in the meta-analysis.

Random Effect Model

Under the random effects model, the assumption of common effect is relaxed, and the effect size θ_i are assumed to have a normal distribution with mean θ and variance τ^2 . The usual Random effect model estimate for τ^2 is given by,

$$\tau^2 = \frac{Q_w - (k - 1)}{\sum w_i - \frac{\sum w_i^2}{\sum w_i}}$$

where Q_w is the heterogeneity statistic, and the weights w_i are calculated as in the fixed effect model method, and k is the number of studies. The τ^2 is set to zero if $Q_w < (k-1)$. In this approach, the weights for each study effect size are as given below.

$$w'_i = \frac{1}{SE(\theta_i)^2 + \tau^2}$$

The pooled estimate is given by,

$$\theta_{DL} = \frac{\sum w'_i \theta_i}{\sum w'_i} \quad \text{and} \quad SE(\theta_{DL}) = \frac{1}{\sqrt{\sum w'_i}}$$

The heterogeneity statistic and its test of significance is as given in the random effect model method. The weights in this method will be smaller and more similar to each other than the weights in fixed effect model method.

When combining results from separate investigations in a meta-analysis, random effects methods enable the modeling of difference between studies by incorporating a heterogeneity parameter τ^2 that accounts explicitly for cross-study variation.

The fixed effect model estimate value is used for conclusion when the heterogeneity statistics p value is greater than $p=0.005$. If the p value is less than $p=0.005$, it is significant, and we use the predicted value from the random effect model to draw our conclusions.

3.2.4 Additional meta-analysis techniques

It will be advantageous to extend meta-analysis by applying several additional meta-analysis techniques such as sensitivity analysis techniques, influence meta-analysis technique, sub-group meta-analysis technique and cumulative meta-analysis technique.

(a) Cumulative meta-analysis

A cumulative meta-analysis is a sequence of meta-analyses starting with a single year and adding the other studies at subsequent years. A cumulative meta-analysis shows how the overall estimate changes over the years. Here, all the researches are presented in chronological order before doing a cumulative meta-analysis to reveal the development of organic farming over time. Here from 2008 to 2021 all the studies are arranged according to chronological order in order to analyze the trend over the years.

(b) Influential meta-analysis

The influence of each study can be estimated by deleting particular study from the analysis and noting the degree to which the size and significance of the treatment effect changes. The influence of individual studies on the summary effect estimate may be displayed. It helps us to identify the outliers among the studies.

(c) Sub group analysis

This subgroup analysis enables us to segment into narrow senses and analyze the detailed study. Consider a scenario in which a meta-analysis is first performed for a more general perspective. Here in subgroup our area of interest will be the subject of meta-analysis.

Here, different regions, different crops, different states, and different years are all considered in the subgroup analysis. The different regions include the north, west, and south. The many crops include wheat, cotton, paddy, and sugarcane. Andhra Pradesh, Karnataka, Maharashtra, Punjab, and Uttar Pradesh are among the different states. The different years include 2008, 2010, 2013, 2017 and 2019.

3.2.5 Software for Statistical analysis

Statistical analyses are carried out with the aid of STATA statistical software version 2.0. STATA was used as an integrated suite for meta-analysis, cumulative meta-analysis, influential meta-analysis, subgroup analysis and graphical displays include Forest plot, and Funnel plot. STATA commands viz. meta, metacum and metainf were used for data processing, combining and estimating the pooled estimate.

RESULTS AND DISCUSSION

IV RESULTS AND DISCUSSION

This chapter is designed to present the results and discussions under the objectives of the study. The study is restricted to data pertaining to the selected studies from the literature on profitability of organic agriculture over inorganic agriculture across the country. Results discussion are presented under the following heads:

4.1 To estimate the profitability of organic agriculture in India through meta-analysis

4.1.1 Performance of organic agriculture from selected studies

4.1.2 Graphical Presentation of Heterogeneity and Publication Bias

4.1.3 Overall profitability of organic agriculture from selected studies

4.2 To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India.

4.2.1 Cumulative meta-analysis

4.2.2 Sub-group analysis

(a) Different regions

(b) Different crops

(c) Different states

(d) Different years

4.2.3 Influential meta-analysis

4.1 To estimate the profitability of organic agriculture in India through meta-analysis

4.1.1 Performance of organic agriculture from selected studies

The increase mean income was calculated by subtracting the mean inorganic income from the mean organic income from the selected 27 studies in order to obtain the performance of organic agriculture and the data are presented in Table 5. From the data it indicates that the performance of organic agriculture in terms of gain in mean income obtained ranges from Rs. 801.60/acre (P.Srikrishna Sudheer on Redgram crop) to

Table 5: Performance of organic agriculture from selected studies

Authors	Crop	State	Mean income of organic agriculture (Rs./acre)	Mean income of inorganic agriculture (Rs./acre)	Mean income gain through organic agriculture (Rs./acre)	SE (MD)
			(a)	(b)	(a-b)	
P.Srikrishna Sudheer	Paddy	Andhra Pradesh	3482.4	2192.0	1290.4	98.9
P.Srikrishna Sudheer	Red Gram	Andhra Pradesh	2428.4	1626.8	801.6	120.8
P.Srikrishna Sudheer	Groundnut	Andhra Pradesh	3638.0	1476.4	2161.6	113.7
Durgesh Yadav	Tomato	Madhya Pradesh	25085.2	11286.0	13799.2	187.4
M.Mohan kumar <i>et al</i>	Ragi	Karnataka	3388.7	2573.6	815.1	171.9
M.Mohan kumar <i>et al</i>	Maize	Karnataka	11136.8	4614.8	6522.0	168.7
D.Kumara charyulu <i>et al</i>	Paddy	Punjab	17828.0	20897.0	-3069.0	313.9
D.Kumara charyulu <i>et al</i>	Wheat	Punjab	21208.0	18319.0	2889.0	322.4
D.Kumara charyulu <i>et al</i>	Cotton	Punjab	17673.0	19608.0	-1935.0	312.2
D.Kumara charyulu <i>et al</i>	Paddy	Uttar Pradesh	11488.0	17190.0	-5702.0	313.8
D.Kumara charyulu <i>et al</i>	Sugarcane	Uttar Pradesh	30961.0	26054.0	4907.0	246.3
D.Kumara charyulu <i>et al</i>	Wheat	Uttar Pradesh	14045.0	10101.0	3944.0	291.2
D.Kumara charyulu <i>et al</i>	Sugarcane	Maharashtra	38854.0	28680.0	10174.0	274.7
D.Kumara charyulu <i>et al</i>	Cotton	Gujarat	34299.0	27112.0	7187.0	251.3
Kavyashree H.V.	Paddy	Karnataka	14174.2	8854.4	5319.8	148.3
Sanap Dattaray <i>et al</i>	Cotton	Maharashtra	10136.4	7567.5	2568.9	149.7
Sanap Dattaray <i>et al</i>	Soyabean	Maharashtra	9260.8	6628.4	2632.4	194.2
Shakthi Singh	Wheat	Punjab	51700.0	39917.0	11783.0	136.5
M.S. Deshmukh <i>et al</i>	Jowar	Maharashtra	-5542.0	-12048	6506.0	73.4
M.S. Deshmukh <i>et al</i>	Turmeric	Maharashtra	134888.1	142980.4	-8092.3	76.5
R.D. Shelke <i>et al</i>	Tomato	Karnataka	86635.4	75770.6	10864.8	137.7
M Shivashankar <i>et al</i>	Sugarcane	Karnataka	36353.9	27028.1	9325.7	137.7
V.R. Naik <i>et al</i>	Chilli	Karnataka	18227.0	7984.0	10243.0	171.0
A.G. Tripathi	Cotton	Andhra Pradesh	7753.4	4371.8	3381.6	131.1
A.G. Tripathi	Pigeon Pea	Andhra Pradesh	9878.5	8001.5	1876.9	165.9
A.G. Tripathi	Mung	Andhra Pradesh	7028.8	5577.6	1451.3	171.8
A.G. Tripathi	Wheat	Andhra Pradesh	7970.5	5701.5	2269.0	148.8

Rs.13799.20/acre (Durgesh Yadav's on tomato crop). This finding is on par with Kondaguri (2012) reported the gain in mean income of Rs. 5,613.4/acre in his study on Paddy at Tungabhadra Command Area of Karnataka.

Further, four studies indicated that negative gain from organic agriculture which is ranged from Rs.-8092.3/acre (M.S. Deshmukh *et al* on turmeric crop) to Rs.-1935/acre (D. Kumara charyulu *et al* on cotton crop). This finding is on par with Raghuvanshi (2010) reported the negative gain (Rs.-4216.4/acre) of organic paddy farmers.

The standard error of mean difference of each study is also presented in the table by using Bootstrapping method.

4.1.2 Graphical Presentation of Heterogeneity and Publication

The graphical presentation of heterogeneity across the selected studies is depicted in the forest plot (Fig. 1). As the studies are listed on Y-axis and their gain in income is plotted across the X-axis. The precision of the study for individual study is represented by the size of box along with their confidence intervals presented by length of arms of the boxes. This clearly explains how the gain in income of individual studies and their associated precision, confidence intervals are scattered in relation to the pooled estimate (Rs.3850/acre). The heterogeneity statistic (τ^2) calculated (4200) while performing meta-analysis was found to be significant with p-value (0.00) leading to the conclusion that studies are not homogenous and the inter-study variation exists across studies. The details of gain in income along with the confidence interval associated for individual studies while preparing forest plot are presented in the Table 6. This finding is on par with Bengtsson et al. (2005) used a meta-analysis of literature to examine the impact of organic farming on species richness and abundance. Organic farming often enhances species richness, with conventional agricultural systems having a 30 per cent higher species richness on average. However, the results varied amongst research, and 16 per cent of them suggested that organic farming had a detrimental influence on species richness.

Table 6: Overall estimate of performance of organic agriculture from selected studies through meta-analysis

No. of studies	Author name_(crop)	Estimate value (Rs./acre)	Lower estimate value (Rs./acre)	Upper estimate value (Rs./acre)
1	Sudheer_Paddy	1290.40	1096.57	1484.23
2	Sudheer_Redgram	801.60	564.84	1038.36
3	Sudheer_Groundnut	2161.60	1938.61	2384.59
4	Yadav_Tomato	13799.20	13431.77	14166.63
5	Kumar_Ragi	815.11	478.14	1152.08
6	Kumar_Maize	6522.07	6191.33	6852.81
7	Charyulu_Paddy_Punjab.	-3069.00	-3684.39	-2453.61
8	Charyulu_Wheat_Punjab.	2889.00	2256.99	3521.01
9	Charyulu_Cotton	-1935.00	-2547.08	-1322.92
10	Charyulu_Paddy_Uttar Pradesh	-5702.00	-6317.13	-5086.87
11	Charyulu_Sugarcane_Uttar Pradesh	4907.00	4424.13	5389.87
12	Charyulu_Wheat_Uttar Pradesh	3944.00	3373.26	4514.74
13	Charyulu_Sugarcane_Maharashta.	10174.00	9635.46	10712.54
14	Charyulu_Cotton	7187.00	6694.40	7679.60
15	Kavyashree_Paddy	5319.80	5029.12	5610.48
16	Dattaray_Cotton	2568.90	2275.42	2862.38
17	Dattaray_Soybean	2632.41	2251.63	3013.20
18	Sing_Wheet	11783.00	11515.41	12050.59
19	Deshmukh_Sorghum	6506.00	6362.05	6649.95
20	Deshmukh_Termeric	-8092.30	-8242.25	-7942.35
21	Shelre_Tomato	10864.84	10594.90	11134.78
22	Shivashankar_Sugarcane	9325.72	9055.83	9595.61
23	Naik_Chilly	10243.00	9907.81	10578.19
24	Tripathi_Cotton	3381.62	3124.56	3638.68
25	Tripathi_Redgram	1876.93	1551.64	2202.22
26	Tripathi_Moong	1451.33	1114.52	1788.14
27	Tripathi_Wheat	2269.00	1977.33	2560.67

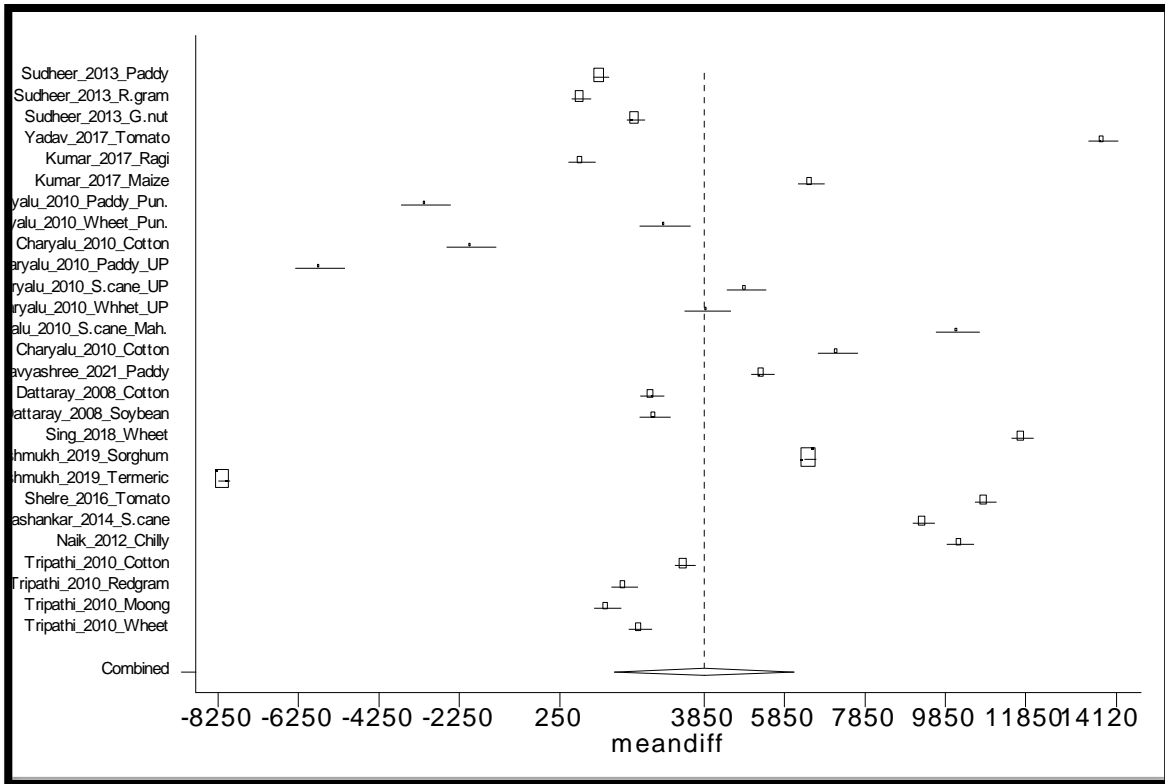


Fig. 1: Forest plot analysis of selected studies

The graphical presentation of publication bias across the selected studies is depicted in the funnel plot (Fig. 2). As the crude for of precision ($1/\text{Standard Error}$) of studies are listed on Y-axis and their gain in income (meandiff) is plotted across the X-axis. The examination of the plot reveals that, majority of the studies are scattered inside the inverted funnel leading to the conclusion that publication bias is at the minimum. This clearly explains, as the precision increases the fewer studies are scattered at the top centre of the graphs whereas large number of studies with less precision are scattered at the bottom of the graphs. Since there are studies ranged from gain in income from Rs.13799.2/acre to Rs.-8092.3/acre, this itself a clear indication that only studies with either positive or negative gain in income are considered for the this study. In case of publication bias authors tend to publish on significant studies either supporting or opposing the gain income leading to publication bias.

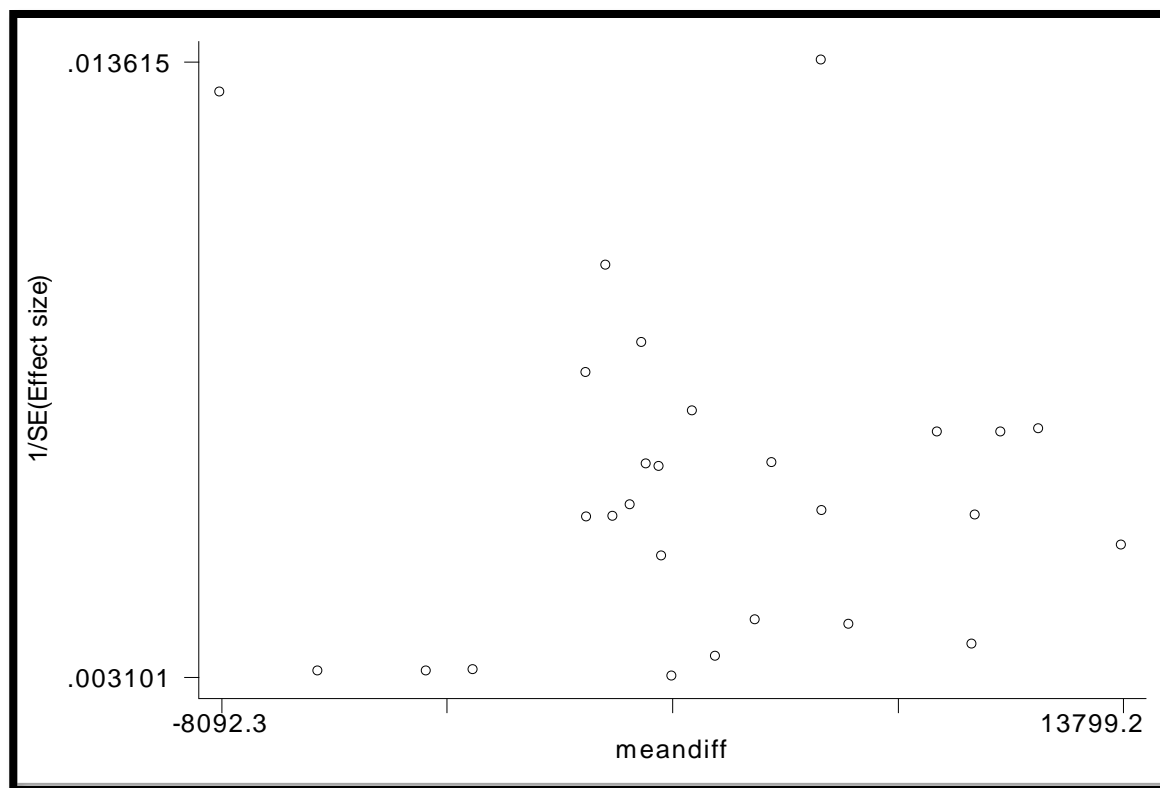


Fig. 2 Funnel plot analysis

4.1.3 Overall profitability of organic agriculture from selected studies

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 7. Data infers that the 27 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs.3850/acre) over inorganic agriculture in India provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus chosen the random effect model's estimate (Rs.3850/acre) against the fixed effect model's estimate (Rs.3127.54/acre). This finding is on par with by Crowder D.W,et.al.(2015)at global scale for financial competitiveness involving 55 crops grown in 14 countries on 5 continents, wherein he reports that organic agriculture was more profitable than inorganic agriculture.

Table 7: Profitability of organic agriculture from selected studies through meta-analysis with different statistical methods

Name of statistical method	Estimate value (Rs./acre)	P value
Fixed effect model	3127.54	0.000
Random effect model	3850.00	0.001
Heterogeneity statistics	4200.00	0.000

4.2 To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India.

4.2.1 Cumulative meta-analysis

Results on overall estimate of performance of organic agriculture from selected studies through cumulative meta-analysis are presented in Table 8. Data infers that the 27 studies used in Cumulative meta-analysis demonstrated the trend of the income of organic agriculture that is Rs.3850.00/acre in the study of Kavyashree_2021_Paddy with lower estimate of Rs. 1613.07/acre and upper estimate of Rs. 6086.41 as compared to inorganic agriculture over the years. Further, the P value (0.001) was found to be significant and hence there is heterogeneity between the studies over the years. Plot data obtained through Cumulative meta-analysis is depicted in Fig.2. Data from the figure indicates that the income was less than pooled estimate in early years and further reduced over years and gradually increased and stabilized later to pooled estimate of Rs.3850.00 /acre. Therefore, plotted data were represented the exact figure presented in the Table 8. This finding is on par with Hanji (2017) conducted Cumulative meta-analysis and reported the trend of prevalence rate of schizophrenia disease among the studies.

Table 8: Overall estimate of performance of organic agriculture from selected studies through cumulative meta-analysis.

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)	Z value	P value
Dattaray_2008_Cotton	2568.90	2275.41	2862.38	17.15	0.00
Dattaray_2008_Soybean	2592.56	2360.11	2825.02	21.86	0.00
Charyulu_2010_Paddy_Punjab.	724.87	-2100.00	3516.39	0.50	0.61
Charyulu_2010_Wheet_Punjab.	1264.12	-922.38	3450.64	1.13	0.25
Charyulu_2010_Cotton	625.68	-1500.00	2791.06	0.56	0.57
Charyulu_2010_Paddy_Uttar Pradesh	-430.00	-3100.00	2238.03	-0.31	0.75
Charyulu_2010_Sugarcane_Uttar Pradesh	333.20	-2200.00	2833.72	0.26	0.79
Charyulu_2010_Wheat_Uttar Pradesh	784.49	-1500.00	3050.01	0.67	0.49
Charyulu_2010_Sugarcane_Maharashtra	1826.21	-813.86	4466.29	1.35	0.17
Charyulu_2010_Cotton	2362.58	-172.85	4898.01	1.82	0.06
Tripathi_2010_Cotton	2456.49	361.00	4551.97	2.29	0.02
Tripathi_2010_Redgram	2408.61	550.09	4267.14	2.54	0.01
Tripathi_2010_Moong	2335.17	648.45	4021.89	2.71	0.00
Tripathi_2010_Wheat	2331.01	822.97	3839.04	3.03	0.00
Naik_2012_Chilly	2858.29	1051.45	4885.13	3.10	0.00
Sudheer_2013_Paddy	2760.47	1141.78	4379.17	3.34	0.00
Sudheer_2013_Redgram	2645.13	1143.18	4147.08	3.45	0.00
Sudheer_2013_Groundnut	2618.61	1254.99	3982.23	3.76	0.00
Shivashankar_2014_Sugarcane	2971.71	1443.77	4499.65	3.81	0.00
Shelre_2016_Tomato	3366.36	1667.68	5065.04	3.88	0.00
Yadav_2017_Tomato	3862.90	2028.40	5697.40	4.12	0.00
Kumar_2017_Ragi	3724.30	1952.03	5496.58	4.11	0.00
Kumar_2017_Maize	3846.14	2138.66	5553.61	4.41	0.00
Sing_2018_Wheat	4176.93	2387.49	5966.36	4.57	0.00
Deshmukh_2019_Sorghum	4270.68	2636.91	5904.45	5.12	0.00
Deshmukh_2019_Turmeric	3793.13	1473.98	6112.27	3.20	0.00
Kavyashree_2021_Paddy	3850.00	1613.06	6086.40	3.37	0.00

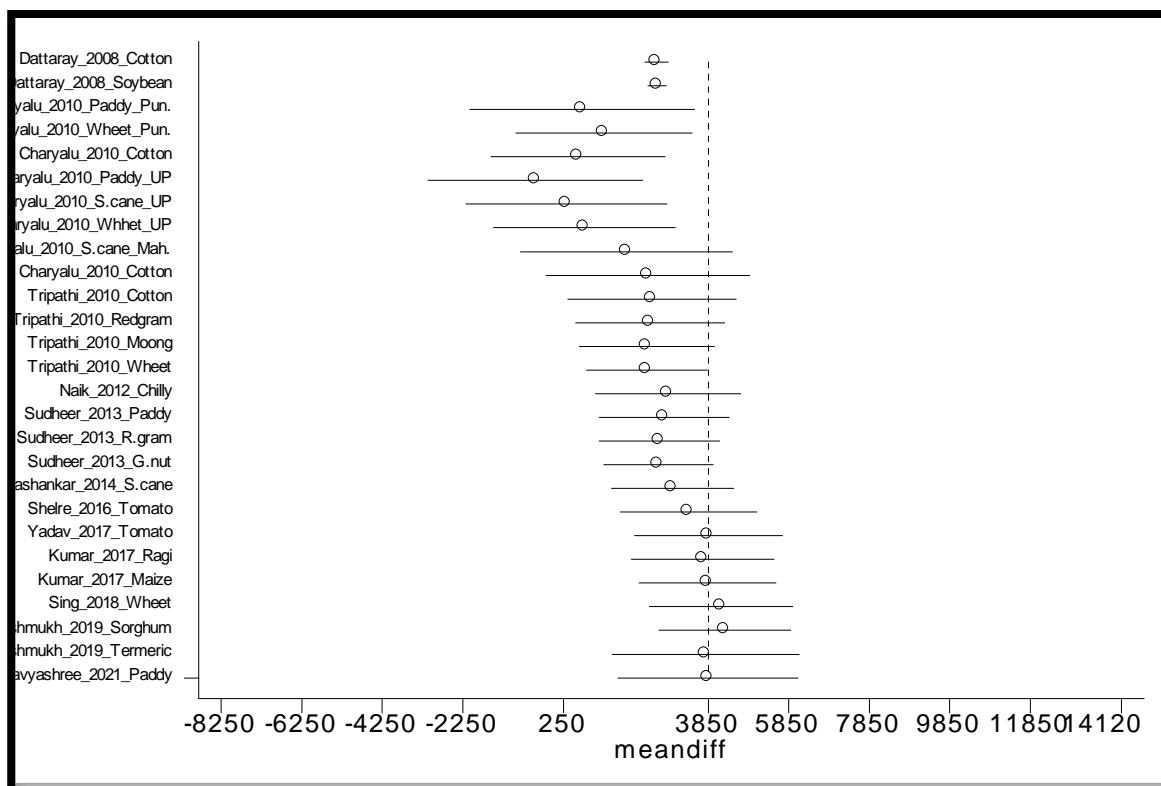


Fig. 3: Cumulative meta-analysis of selected studies

4.2.2 Sub-group analysis

(a) Different regions

(i) **North region:** Results on overall estimate of performance of organic agriculture from 8 selected studies through meta-analysis in North Region are presented in Table 9. Data shows that the highest estimate value was found in Yadav study on Tomato (Rs. 13799.20/acre) followed by Sing study on Wheat (Rs. 11783.00/acre), Charyulu study on Sugar Cane (4907.00/acre), Charyulu study on Wheat in Uttar Pradesh (3944.00) and Charyulu study on Wheat in Punjab (Rs. 2889.00/acre). Further, out of 8 studies, 3 studies viz., Charyulu study on Paddy in Punjab (Rs.-3069.00/acre), Charyulu study on Cotton (Rs.-1935.00/acre) and Charyulu study on Paddy in Uttar Pradesh (Rs.-5702.00/acre) are found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs.-6317.13/acre (Charyulu study on Paddy in Uttar Pradesh) to Rs. 13431.77/acre (Yadav

study on Tomato). Similarly, the estimate upper value is ranged from Rs. -5086.87/acre (Charyulu study on Paddy in Uttar Pradesh) to Rs.14166.63/acre (Yadav study on Tomato).

Table 9: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in North Region.

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Yadav_Tomato	13799.20	13431.77	14166.63
Charyulu_Paddy_Punjab.	-3069.00	-3684.39	-2453.61
Charyulu_Wheat_Punjab.	2889.00	2256.99	3521.01
Charyulu_Cotton	-1935.00	-2547.08	-1322.92
Charyulu_Paddy_Uttar Pradesh	-5702.00	-6317.13	-5086.87
Charyulu_Sugarcane_Uttar Pradesh	4907.00	4424.13	5389.87
Charyulu_Wheat_Uttar Pradesh	3944.00	3373.26	4514.74
Sing_Wheat	11783.00	11515.41	12050.59

Results on overall profitability of organic agriculture from 8 selected studies through meta-analysis with different statistical methods are presented in Table 10. Data infers that the 8 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 3330.35/acre) as compared to inorganic agriculture in North region provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Hachappalavar and Kunal (2002) attempted to estimate the yield levels and economics of organic farming in Shimoga of Karnataka. Their results showed that, the organic farms produces 22 and 18 percent higher yield of paddy and sugarcane respectively over the inorganic farms.

Table 10: Overall profitability of organic agriculture from selected studies through meta- analysis in North Region

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	7114.97	0.000
Random effect model	3330.35	0.195
Heterogeneity statistics	6370.55	0.000

(ii) South region: Results on overall estimate of performance of organic agriculture from 13 selected studies through meta-analysis in South Region are presented in Table 11. Data shows that the highest estimate value was found in Shelke study on Tomato (Rs. 10864.84/acre) followed by Naik study on chilly (Rs. 10243.00/acre), Shivashankar study on Sugar Cane (9325.72/acre. Further it shows that the lowest estimate value was found in Sudheer's study on Redgram (Rs801.60/acre) preceded by Kumar's study on Ragi (Rs815.11/acre) and Sudheer's study on Paddy (Rs1290.40/acre). Further, data reveals that the estimate lower value is ranged from Rs. 564.84/acre (Sudheer's study on Redgram) to Rs. 10594.90/acre (Shelke study on Tomato). Similarly, the estimate upper value is ranged from Rs. 1038.36/acre (Sudheer's study on Redgram) to Rs. 11134.78/acre (Shelke study on Tomato).

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 12. Data infers that the 13 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 4332.26/acre) over inorganic agriculture in South region provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Singh (2003) carried out a study on comparative economics of production of organic produce in Himachal Pradesh. Where he reported that the net income per hectare from organic farming was found to be 2 to 3 times higher both in case of maize and wheat.

Table 11: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in South Region.

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Sudheer_Paddy	1290.40	1096.57	1484.23
Sudheer_Redgram	801.60	564.84	1038.36
Sudheer_Groundnut	2161.60	1938.61	2384.59
Kumar_Ragi	815.11	478.14	1152.08
Kumar_Maize	6522.07	6191.33	6852.81
Kavyashree_Paddy	5319.80	5029.12	5610.48
Shelke_Tomato	10864.84	10594.90	11134.78
Shivashankar_Sugarcane	9325.72	9055.83	9595.61
Naik_Chilly	10243.00	9907.81	10578.19
Tripathi_Cotton	3381.62	3124.56	3638.68
Tripathi_Redgram	1876.93	1551.64	2202.22
Tripathi_Moong	1451.33	1114.52	1788.14
Tripathi_Wheet	2269.00	1977.33	2560.67

Table 12: Overall profitability of organic agriculture from selected studies through meta-analysis in South Region

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	3972.30	0.000
Random effect model	4332.26	0.000
Heterogeneity statistics	8212.07	0.000

(iii) West region: Results on overall estimate of performance of organic agriculture from 6 selected studies through meta-analysis in West region are presented in Table 13. Data shows that the highest estimate value was found in Charyulu study on Sugarcane (Rs. 10174.00/acre) followed by Charyulu study on cotton (Rs. 7187.00/acre), Deshmukh study on sorghum (6506.00/acre), Dattaray study on soyabean (2632.41) and Dattaray study on cotton (Rs. 2568.90/acre). Further, out of 6 studies, 1 study viz., Deshmukh's study on Turmeric (Rs.-8092.30/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs-8242.25/acre (Deshmukh's study on Turmeric) to Rs. 9635.46/acre (Charyulu study on Sugarcane). Similarly, the estimate upper value is ranged from Rs. -7942.35/acre (Deshmukh's study on Turmeric) to Rs. 10712.54/acre (Charyulu study on Sugarcane).

Table 13: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in West Region

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Sugarcane_Maharashtra.	10174.00	9635.46	10712.54
Charyulu_Cotton	7187.00	6694.40	7679.60
Dattaray_Cotton	2568.90	2275.42	2862.38
Dattaray_Soybean	2632.41	2251.63	3013.20
Deshmukh_Sorghum	6506.00	6362.05	6649.95
Deshmukh_Turmeric	-8092.30	-8242.25	-7942.35

Data on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 14. Data infers that the 6 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 3494.48/acre) over inorganic agriculture in West region provided by Random Effect Model. Because the p value of the heterogeneity statistics in

this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Mane (2006) studied economics of production of organic vs. inorganic soybean in Nanded district, reported that the net profit estimated to Rs. 8854.33 and Rs. 8160.36 for organic and inorganic respectively and the input -output ratio was 1.57 and 1.48 for organic and inorganic respectively.

Table 14: Overall profitability of organic agriculture from selected studies through meta-analysis in West Region

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	0561.87	0.000
Random effect model	3494.48	0.304
Heterogeneity statistics	2200.00	0.000

(iv) Comparison of three regions: Results on mean estimate of performance of organic agriculture from selected studies through meta-analysis in different regions are presented in Table 15. Data reveals that the mean estimated value performance of organic agriculture was highest (Rs.4332.54/acre) in South followed by Rs. 3496.002/acre in West and Rs. 3327.025/acre in North.

Table 15: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different regions.

Name of Region	Number of selected studies	Mean of Estimate value (Rs/acre)	Mean of lower estimate value (Rs/acre)	Mean of upper estimate value (Rs/acre)
North Region	8	3327.02	2806.62	3847.43
South Region	13	4332.54	4048.09	4616.98
West Region	6	3496.00	3162.78	3829.22
Total/Average	27			

Mean of Lower estimated value ranges from (Rs. 2806.62/acre) to (Rs. 4048.092/acre) and Mean of upper estimated value ranges from (Rs. 3829.22/acre) to (Rs. 4616.988/acre)

(b) Different crops

(i) Cotton crop: Results on overall estimate of performance of organic agriculture from 4 selected studies through meta-analysis in Cotton crop are presented in Table 16. Data shows that the highest estimate value was found in Charyulu study on cotton in Gujarath(Rs. 7187.00/acre) followed by Tripathi’s study on cotton (Rs. 3381.62/acre), Dattaray study on cotton (2568.90/acre). Further, out of 4 studies, 1 study viz., Charyulu study on cotton in Punjab (Rs-1935.00/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs--2547.08/acre (Charyulu study on cotton in Punjab) to Rs. 6694.40/acre (Charyulu study on cotton in Gujarath). Similarly, the estimate upper value is ranged from Rs-1322.92/acre (Charyulu study on cotton in Punjab) to Rs. 7679.60/acre (Charyulu study on cotton in Gujarath).

Table 16: Overall estimate of performance of organic agriculture from selected studies through meta-analysis for Cotton crop

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Cotton	-1935.00	-2547.08	-1322.92
Charyulu_Cotton Gujarath	7187.00	6694.40	7679.60
Dattaray_Cotton	2568.90	2275.42	2862.38
Tripathi_Cotton	3381.62	3124.56	3638.68

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 17. Data infers that the 4 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 2807.57/acre) over inorganic agriculture in Cotton

provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This finding is on par with Kondaguri (2012) reported the gain in mean income of Rs. 5,613.4/acre in his study on Paddy at Tungabhadra Command Area of Karnataka.

Table 17: Overall profitability of organic agriculture from selected studies through meta-analysis in Cotton with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	3144.72	0.000
Random effect model	2807.57	0.027
Heterogeneity statistics	0541.31	0.000

(ii) Paddy crop: Results on overall estimate of performance of organic agriculture from 4 selected studies through meta-analysis in Paddy crop are presented in Table 18. Data shows that the highest estimate value was found in Kavyashree study on paddy (Rs. 5319.80/acre) followed Sudheer study on paddy crop (Rs. 1290.40/acre). Further, out of 4 studies, 2 studies viz., Charyulu study on Paddy in Punjab (Rs-3069.00/acre), Charyulu study on Paddy in Uttar Pradesh (Rs-5702.00/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs-6317.13/acre, (Charyulu study on Paddy in Uttar Pradesh) to Rs. 5029.12/acre (Kavyashree study on paddy). Similarly, the estimate upper value is ranged from Rs-5086.87/acre (Charyulu study on Paddy in Uttar Pradesh) to Rs. 5610.48/acre (Kavyashree study on paddy).

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 19. Data infers that the 4 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled loss of organic agriculture (Rs. -530.15/acre) over inorganic agriculture in Paddy provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's

estimate value for conclusion. This finding is on par with Raghuvanshi (2010) reported the negative gain (Rs.-4216.4/acre) of organic paddy farmers.

Table 18: Overall estimate of performance of organic agriculture from selected studies through meta-analysis for Paddy crop

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Sudheer_Paddy	1290.40	1096.57	1484.23
Charyulu_Paddy_Punjab.	-3069.00	-3684.39	-2453.61
Charyulu_Paddy_Uttar Pradesh	-5702.00	-6317.13	-5086.87
Kavyashree_Paddy	5319.80	5029.12	5610.48

Table 19: Overall profitability of organic agriculture from selected studies through meta-analysis in Paddy with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	1695.00	0.000
Random effect model	-530.15	0.786
Heterogeneity statistics	1399.77	0.000

(iii) Sugar cane crop: Results on overall estimate of performance of organic agriculture from 3 selected studies through meta-analysis in Sugarcane crop are presented in Table 20. Data shows that the highest estimate value was found in Charyulu study on sugarcane in Maharashtra (Rs. 10174.00/acre) followed by Shivashanklar's study on sugarcane (Rs. 9325.72/acre), Charyulu study on sugarcane in Uttar Pradesh (4907.00/acre). Further, data reveals that the estimate lower value is ranged from Rs4424.13/acre (Charyulu study on sugarcane in Uttar Pradesh) to Rs. 9635.46/acre (Charyulu study on cotton in Gujarath). Similarly, the estimate upper value is ranged from Rs5389.87/acre (Charyulu study on sugarcane in Maharashtra) to Rs. 10712.54/acre (Charyulu study on sugarcane in Maharashtra).

Table 20: Overall estimate of performance of organic agriculture from selected studies through meta-analysis for Sugarcane

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Sugarcane_Uttar Pradesh	4907.00	4424.13	5389.87
Shivashankar_Sugarcane	9325.72	9055.83	9595.61
Charyulu_Sugarcane_Maharashtra.	10174.00	9635.46	10712.54

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 21. Data infers that the 3 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 8136.57/acre) over inorganic agriculture in Sugarcane provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Kshirsagar (2006) studied the organic sugarcane farming in Maharashtra and reported that profit from organic sugarcane crop at Rs. 79694 per hectare were higher by 15.63 percent than inorganic sugarcane crop.

Table 21: Overall profitability of organic agriculture from selected studies through meta-analysis in Sugarcane with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	8579.07	0.000
Random effect model	8136.57	0.000
Heterogeneity statistics	285.25	0.000

(iv) Wheat crop: Results on overall estimate of performance of organic agriculture from 4 selected studies through meta-analysis in Wheat crop are presented in Table 22. Data shows that the highest estimate value was found in Singh study on wheat(Rs. 11783.00) followed by Charyulu study on wheat in Uttar Pradesh(Rs. 3944.00/acre), Charyulu study on wheat in Punjab (2889.00/acre)and Tripathi study on wheat(Rs2269.00/acre).Further, data reveals that the estimate lower value is ranged from Rs2256.99/acre (Tripathi study on wheat) to Rs1977.33/acre (Singh study on wheat). Similarly, the estimate upper value is ranged from Rs3521.01/acre Tripathi study on wheat) to Rs. 12050.59/acre (Singh study on wheat).

Table 22: Overall estimate of performance of organic agriculture from selected studies through meta-analysis for wheat crop

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Wheat_Punjab.	2889.00	2256.99	3521.01
Charyulu_Wheat_Uttar Pradesh	3944.00	3373.26	4514.74
Sing_Wheat	11783.00	11515.41	12050.59
Tripathi_Wheat	2269.00	1977.33	2560.67

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 23. Data infers that the 4 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 5223.52/acre) over inorganic agriculture in Wheat provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Singh (2003) carried out a study on comparative economics of production of organic produce in Himachal Pradesh. Where he reported that the net income per hectare from organic farming was found to be 2 to 3 times higher both in case of maize and wheat.

Table 23: Overall profitability of organic agriculture from selected studies through meta-analysis in Wheat with different statistical methods.

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	6728.82	0.000
Random effect model	5223.52	0.066
Heterogeneity statistics	2501.88	0.000

(v) **Comparison of different crops:** Results on mean estimate of performance of organic agriculture from selected studies through meta-analysis in different crops are presented in Table 24. Data reveals that the mean estimated value performance of organic agriculture was highest (Rs. 8135.57/acre) in Sugarcane followed by Rs. 5221.25/acre in Wheat, Rs.2800.63/acre in Cotton. However, it was observed that the negative gain was obtained (Rs. -540.2/acre) in Paddy.

Mean of Lower estimated value ranges from (Rs-968.958/acre) to (Rs7705.14/acre) and Mean of upper estimated value ranges from (Rs-111.443/acre) to (Rs8566.007/acre)

Table 24: Mean estimate of performance of organic agriculture from selected studies through meta-analysis for different crops

Name of crop	Number of selected studies	Mean of Estimate value (Rs/acre)	Mean of lower estimate value (Rs/acre)	Mean of upper estimate value (Rs/acre)
Cotton	4	2800.63	2386.82	3214.43
Paddy	4	-540.20	-968.95	-111.44
Sugarcane	3	8135.57	7705.14	8566.00
Wheat	4	5221.25	4780.74	5661.75
Total/Average	15			

(c) Different states

(i) Andhra Pradesh: Results on overall estimate of performance of organic agriculture from 7 selected studies through meta-analysis in Cotton crop are presented in Table 25. Data shows that the highest estimate value was found in Tripathi study on cotton (Rs. 3381.62/acre) followed by Tripathi's study on wheat (Rs. 2269.00/acre), Sudheer study on Groundnut (2161.60/acre), Tripathi's study on Redgram (Rs. 1876.93/acre), Tripathi's study on moong (Rs. 1451.33/acre) Sudheer study on Paddy (Rs1290.40/acre) and Sudheer study on Redgram(Rs. 801.60/acre). Further, data reveals that the estimate lower value is ranged from Rs564.84/acre (Sudheer study on Redgram) to Rs. 3124.56/acre (Tripathi study on cotton). Similarly, the estimate upper value is ranged from Rs1038.36/acre (Sudheer study on Redgram) to Rs. 3638.68/acre (Tripathi study on cotton).

Table 25: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in Andhra Pradesh

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Sudheer_Paddy	1290.40	1096.57	1484.23
Sudheer_Redgram	801.60	564.84	1038.36
Sudheer_Groundnut	2161.60	1938.61	2384.59
Tripathi_Cotton	3381.62	3124.56	3638.68
Tripathi_Redgram	1876.93	1551.64	2202.22
Tripathi_Moong	1451.33	1114.52	1788.14
Tripathi_Wheat	2269.00	1977.33	2560.67

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 26. Data infers that the 7 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 1889.86/acre) over inorganic agriculture in Andhra Pradesh provided by Random Effect Model. Because the p value of the heterogeneity

statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion.

Table 26: Overall profitability of organic agriculture from selected studies through meta-analysis in Andhra Pradesh with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	1827.34	0.000
Random effect model	1889.86	0.000
Heterogeneity statistics	264.34	0.000

(b) Karnataka: Results on overall estimate of performance of organic agriculture from 6 selected studies through meta-analysis in Karnataka state are presented in Table 27. Data shows that the highest estimate value was found in Shelke study on tomato (Rs. 10864.84/acre) followed by Naik study on chilly (Rs. 10243.00/acre), Shivashankar study on Sugarcane (Rs9325.72/acre), Kumar study on maize (Rs6522.07/acre), Kavyashree study on paddy (Rs.5319.80/acre) and Kumar study on Ragi (Rs. 815.11/acre). Further, data reveals that the estimate lower value is ranged from Rs478.14/acre (Kumar study on Ragi) to Rs. 10594.90/acre (Shelke study on tomato). Similarly, the estimate upper value is ranged from Rs1152.08/acre Kumar study on Ragi) to Rs. 11134.78/acre (Shelke study on tomato).

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 28. Data infers that the 6 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 7182.35/acre) over inorganic agriculture in Karnataka provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Hachappalavar and Kunal (2002) attempted to estimate the yield levels and economics of organic farming in Shimoga of Karnataka. Their results showed that, the organic farms produces 22 and 18 percent higher yield of paddy and sugarcane respectively over the inorganic farms.

Table 27: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in Karnataka

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Kumar_Ragi	815.11	478.14	1152.08
Kumar_Maize	6522.07	6191.33	6852.81
Kavyashree_Paddy	5319.80	5029.12	5610.48
Shelre_Tomato	10864.84	10594.90	11134.78
Shivashankar_Sugarcane	9325.72	9055.83	9595.61
Naik_Chilly	10243.00	9907.81	10578.19

Table 28: Overall profitability of organic agriculture from selected studies through meta-analysis in Karnataka with different statistical methods.

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	7530.87	0.000
Random effect model	7182.35	0.000
Heterogeneity statistics	2791.24	0.000

(iii) Maharashtra: Results on overall estimate of performance of organic agriculture from 5 selected studies through meta-analysis in Maharashtra are presented in Table 29. Data shows that the highest estimate value was found in Charaylu study on sugarcane (Rs. 10174.00/acre) followed by Deshmukh study on sorghumt (Rs6506.00/acre),Dattaray study on soyabean (2632.41/acre)and Dattaray study on cotton(Rs. 2568.90/acre). Further, out of 5 studies, 1 study viz., Deshmukh study on turmeric crop (Rs-8092.30/acre)is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs-8242.25/acre (Deshmukh study on turmeric crop) to Rs. 9635.46/acre (Charaylu study on sugarcane). Similarly, the estimate upper value is ranged from Rs-7942.35/acre (Deshmukh study on turmeric crop) to Rs10712.54/acre (Charaylu study on sugarcane).

Table 29: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in Maharashtra

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Sugarcane_Maharashtra.	10174.00	9635.46	10712.54
Dattaray_Cotton	2568.90	2275.42	2862.38
Dattaray_Soybean	2632.41	2251.63	3013.20
Deshmukh_Sorghum	6506.00	6362.05	6649.95
Deshmukh_Turmeric	-8092.30	-8242.25	-7942.35

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 30. Data infers that the 5 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 2756.39/acre) over inorganic agriculture in Maharashtra provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Kshirsagar (2006) studied the organic sugarcane farming in Maharashtra and reported that profit from organic sugarcane crop at Rs. 79694 per hectare were higher by 15.63 percent than inorganic sugarcane crop.

Table 30: Overall profitability of organic agriculture from selected studies through meta-analysis in Maharashtra with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	323.79	0.000
Random effect model	2756.39	0.467
Heterogeneity statistics	2100.00	0.000

(iv) Punjab: Results on overall estimate of performance of organic agriculture from 4 selected studies through meta-analysis in Punjab are presented in Table 31. Data shows that the highest estimate value was found in Singh study on wheat (Rs. 11783.00/acre) followed by Charaylu study on wheat (Rs.2889.00/acre). Further, out of 4 studies, 2 studies viz., Charaylu study on cotton (Rs-1935.00/acre) and Charaylu study on paddy (Rs-3069.00/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs-3684.39/acre (Charaylu study on paddy) to Rs.11515.41/acre (Singh study on wheat). Similarly, the estimate upper value is ranged from Rs-2453.61/acre (Charaylu study on paddy) to Rs. 12050.59/acre (Singh study on wheat).

Table 31: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in Punjab

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Paddy_Punjab.	-3069.00	-3684.39	-2453.61
Charyulu_Wheat_Punjab.	2889.00	2256.99	3521.01
Charyulu_Cotton	-1935.00	-2547.08	-1322.92
Sing_Wheat	11783.00	11515.41	12050.59

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 32. Data infers that the 4 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 2419.62/acre) over inorganic agriculture in Punjab provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion.

Table 32: Overall profitability of organic agriculture from selected studies through meta-analysis in Punjab with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	7278.73	0.000
Random effect model	2419.62	0.565
Heterogeneity statistics	3230.37	0.000

(v) **Uttar Pradesh:** Results on overall estimate of performance of organic agriculture from 3 selected studies through meta-analysis in Uttar Pradesh are presented in Table 33. Data shows that the highest estimate value was found in Charaylu study on sugarcane (Rs. 4907.00/acre) followed by Charaylu study on wheat (Rs. 3944.00/acre). Further, out of 3 studies, 1 study viz., Charaylu study on paddy (Rs-5702.00/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs.-6317.13/acre (Charaylu study on paddy) to Rs. 4424.13/acre (Charaylu study on sugarcane). Similarly, the estimate upper value is ranged from Rs-5086.87/acre (Charaylu study on paddy) to Rs. 5389.87/acre (Charaylu study on sugarcane).

Table 33: Overall estimate of performance of organic agriculture from selected studies through meta-analysis in Uttar Pradesh

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Paddy_Uttar Pradesh	-5702.00	-6317.13	-5086.87
Charyulu_Sugarcane_ Uttar Pradesh	4907.00	4424.13	5389.87
Charyulu_Wheat_ Uttar Pradesh	3944.00	3373.26	4514.74

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 34. Data infers that the 3 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 1051.64/acre) over inorganic agriculture in Uttar Pradesh provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Mane (2006) studied economics of production of organic vs. inorganic soybean in Nanded district, reported that the net profit estimated to Rs. 8854.33 and Rs. 8160.36 for organic and inorganic respectively and the input -output ratio was 1.57 and 1.48 for organic and inorganic respectively.

Table 34: Overall profitability of organic agriculture from selected studies through meta-analysis in Uttar Pradesh with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	1808.10	0.000
Random effect model	1051.64	0.745
Heterogeneity statistics	784.61	0.000

(vi) Comparison of different states: Results on mean estimate of performance of organic agriculture from selected studies through meta-analysis in different states are presented in Table 35. Data reveals that the mean estimated value performance of organic agriculture was highest (Rs. 7181.757/acre) in Karnataka followed by Rs. 2757.802/acre in Maharashtra, Rs. 2417/acre in Punjab Rs. 1890.354/acre in Andhra Pradesh and (Rs1049.667/acre) in Uttar Pradesh .

Mean of Lower estimated value ranges from (Rs 493.42/acre) to (Rs6876.188/acre) and Mean of upper estimated value ranges from (Rs1605.913/acre) to (Rs7487.325/acre).

Table 35: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different states

Name of state	Number of selected studies	Mean of Estimate value (Rs/acre)	Mean of lower estimate value (Rs/acre)	Mean of upper estimate value (Rs/acre)
Andhra Pradesh	7	1890.35	1624.01	2156.69
Karnataka	6	7181.75	6876.18	7487.32
Maharashtra	5	2757.80	2456.46	3059.14
Punjab	4	2417.00	1885.23	2948.76
Uttara Pradesh	3	1049.66	493.42	1605.91
Total/Average	25			

(d) Different years

(i) **Year 2008:** Results on overall estimate of performance of organic agriculture from 2 selected studies through meta-analysis in 2008 are presented in Table 36. Data shows that the highest estimate value was found in Dattaray study on soyabean (Rs. 2632.41/acre) followed by Dattaray study on cotton (Rs. 2568.90/acre). Further, data reveals that the estimate lower value is ranged from Rs2251.63/acre (Dattaray study on soyabean) to Rs. 2275.42/acre (Dattaray study on cotton). Similarly, the estimate upper value is ranged from Rs.2862.38/acre (Dattaray study on cotton) to Rs. 3013.20/acre (Dattaray study on soyabean).

Table 36: Overall estimate of organic agriculture from selected studies through meta-analysis in 2008

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Dattaray_Cotton	2568.90	2275.42	2862.38
Dattaray_Soybean	2632.41	2251.63	3013.20

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 37. Data infers that the 2 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 2592.56/acre) over inorganic agriculture in 2008 provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Singh (2003) carried out a study on comparative economics of production of organic produce in Himachal Pradesh. Where he reported that the net income per hectare from organic farming was found to be 2 to 3 times higher both in case of maize and wheat.

Table 37: Overall profitability of organic agriculture from selected studies through meta-analysis in 2008 with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	2592.56	0.000
Random effect model	2592.56	0.000
Heterogeneity statistics	0.067	0.000

(ii) Year 2010: Results on overall estimate of performance of organic agriculture from 12 selected studies through meta-analysis in 2010 are presented in Table 38. Data shows that the highest estimate value was found in Charaylu study on sugarcane in Maharashtra (Rs. 10174.00/acre) followed by Charaylu study on cotton (Rs. 7187.00/acre), Charaylu study on sugarcane in Uttar Pradesh (Rs.4907/acre), Charaylu study on wheat in Uttar Pradesh (Rs. 3944.00/acre),Tripathi study on cotton (Rs.3381.62/acre), Charaylu study on wheat in Punjab (Rs.2889.00/acre), Tripathi study on wheat (Rs.2269/acre), Tripathi study on Redgram(Rs.1876.93/acre) and Tripathi study on moong (Rs.1451.33 /acre).Further, out of 12 studies, 3 studies viz.,Charaylu study on paddy in Uttar Pradesh(Rs-5702.00/acre), Charaylu study on paddy in Punjab(Rs-3069.00/acre), Charaylu study on cotton(Rs.-1935.00/acre) are found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs.-6317.13/acre (Charaylu study on paddy) to Rs. 9635.46/acre (Charaylu

study on sugarcane). Similarly, the estimate upper value is ranged from Rs-5086.87/acre (Charaylu study on paddy) to Rs. 5389.87/acre (Charaylu study on sugarcane).

Table 38: Overall estimate of organic agriculture from selected studies through meta-analysis in 2010

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Charyulu_Paddy_Punjab.	-3069.00	-3684.39	-2453.61
Charyulu_Wheat_Punjab.	2889.00	2256.99	3521.01
Charyulu_Cotton	-1935.00	-2547.08	-1322.92
Charyulu_Paddy_Uttara Pradesh	-5702.00	-6317.13	-5086.87
Charyulu_Sugarcane_Uttara Pradesh	4907.00	4424.13	5389.87
Charyulu_Wheat_Uttara Pradesh	3944.00	3373.26	4514.74
Charyulu_Sugarcane_Maharashtra.	10174.00	9635.46	10712.54
Charyulu_Cotton	7187.00	6694.40	7679.60
Tripathi_Cotton	3381.62	3124.56	3638.68
Tripathi_Redgram	1876.93	1551.64	2202.22
Tripathi_Moong	1451.33	1114.52	1788.14
Tripathi_Wheat	2269.00	1977.33	2560.67

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 39. Data infers that the 12 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 2284.81/acre) over inorganic agriculture in 2010 provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion.

Table 39: Overall profitability of organic agriculture from selected studies through meta-analysis in 2010 with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	2624.47	0.000
Random effect model	2284.81	0.000
Heterogeneity statistics	2543.25	0.000

(iii) Year 2013: Results on overall estimate of performance of organic agriculture from 3 selected studies through meta-analysis in 2013 are presented in Table 40. Data shows that the highest estimate value was found in Sudheer study on Groundnut (Rs. 2161.60/acre) followed by Sudheer study on paddy (Rs. 1290.40/acre) and Sudheer study on Red gram (Rs. 801.60/acre). Further, data reveals that the estimate lower value is ranged from Rs.564.84/acre (Sudheer study on Redgram) to Rs.1938.61/acre (Sudheer study on Groundnut). Similarly, the estimate upper value is ranged from Rs.1038.36/acre (Sudheer study on Redgram) to Rs. 2384.59/acre (Sudheer study on Groundnut).

Table 40: Overall estimate of organic agriculture from selected studies through meta-analysis in 2013

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Sudheer_Paddy	1290.40	1096.57	1484.23
Sudheer_Redgram	801.60	564.84	1038.36
Sudheer_Groundnut	2161.60	1938.61	2384.59

Results on profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 41. Data infers that the 3 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 1418.33/acre) over inorganic agriculture in 2013 provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance

is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion.

Table 41: Overall profitability of organic agriculture from selected studies through meta-analysis in 2013 with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	1426.71	0.000
Random effect model	1418.33	0.000
Heterogeneity statistics	70.40	0.000

(iv) Year 2017: Results on overall estimate of performance of organic agriculture from 3 selected studies through meta-analysis in 2017 are presented in Table 42. Data shows that the highest estimate value was found in Yadav study on tomato (Rs. 13799.20/acre) followed by Kumar study on Maize (Rs. 6522.07/acre) and Kumar study on Ragi (Rs. 815.11/acre). Further, data reveals that the estimate lower value is ranged from Rs.478.14/acre (Kumar study on Ragi) to Rs. 13431.77/acre (Yadav study on tomato). Similarly, the estimate upper value is ranged from Rs.1152.08/acre (Kumar study on Ragi) to Rs. 14166.63/acre (Yadav study on tomato).

Table 42: Overall estimate of organic agriculture from selected studies through meta-analysis in 2017

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Yadav_Tomato	13799.20	13431.77	14166.63
Kumar_Ragi	815.11	478.14	1152.08
Kumar_Maize	6522.07	6191.33	6852.81

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 43. Data infers that the 3 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs. 7045.14/acre) over inorganic agriculture in 2017 provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Mane (2006) studied economics of production of organic vs. inorganic soybean in Nanded district, reported that the net profit estimated to Rs. 8854.33 and Rs. 8160.36 for organic and inorganic respectively and the input -output ratio was 1.57 and 1.48 for organic and inorganic respectively.

Table 43: Overall profitability of organic agriculture from selected studies through meta-analysis in 2017 with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	6665.66	0.000
Random effect model	7045.14	0.055
Heterogeneity statistics	2606.68	0.000

(v) Year 2019: Results on overall estimate of performance of organic agriculture from 2 selected studies through meta-analysis in 2019 are presented in Table 44. Data shows that the highest estimate value was found in Deshmukh study on sorghum (Rs. 6506.00/acre). Further, out of 2 studies, 1 study viz., Deshmukh study on turmeric (Rs.-8092.30/acre) is found to be negative gain in mean income in organic agriculture as compared to inorganic agriculture. Further, data reveals that the estimate lower value is ranged from Rs.-8242.25/acre (Deshmukh study on turmeric) to Rs. 6362.05/acre (Deshmukh study on sorghum). Similarly, the estimate upper value is ranged from Rs.-7942.35/acre (Deshmukh study on turmeric) to Rs.6649.95/acre (Deshmukh study on sorghum).

Table 44: Overall estimate of organic agriculture from selected studies through meta-analysis in 2019

Author	Estimate value (Rs/acre)	Estimate lower value (Rs/acre)	Estimate upper value (Rs/acre)
Deshmukh_Sorghum	6506.00	6362.05	6649.95
Deshmukh_Turmeric	-8092.30	-8242.25	-7942.35

Results on overall profitability of organic agriculture from selected studies through meta-analysis with different statistical methods are presented in Table 45. Data infers that the 2 studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled loss of organic agriculture (Rs. -793.134/acre) over inorganic agriculture in 2019 provided by Random Effect Model. Because the p value of the heterogeneity statistics in this instance is 0.000, which is less than $p=0.05$, it is significant, thus choose the random effect model's estimate value for conclusion. This findings is on par with Kshirsagar (2006) studied the organic sugarcane farming in Maharashtra and reported that profit from organic sugarcane crop at Rs. 79694 per hectare were higher by 15.63 percent than inorganic sugarcane crop.

Table 45: Overall profitability of organic agriculture from selected studies through meta-analysis in 2019 with different statistical methods

Name of statistical method	Estimate value (Rs/acre)	P value
Fixed effect model	-495.253	0.000
Random effect model	-793.134	0.055
Heterogeneity statistics	1900.00	0.000

(vi) Comparison of different years: Results on mean estimate of performance of organic agriculture from selected studies through meta-analysis in different years are presented in Table 46. Data reveals that the mean estimated value performance of organic agriculture was highest (Rs. 7045.46/acre) in 2017 followed by Rs.2600.66/acre in 2008, Rs.

2281.16/acre in 2010 and Rs.1417.87/acre in 2013. However, it was observed that the negative gain was obtained (Rs. -793.15/acre) in 2019.

Mean of Lower estimated value ranges from (Rs940.1/acre) to (Rs6700/acre) and Mean of upper estimated value ranges from (Rs-646.2/acre) to (Rs7390.50/acre)

Table 46: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different years

Year	Number of selected studies	Mean of Estimate value (Rs/acre)	Mean of lower estimate value (Rs/acre)	Mean of upper estimate value (Rs/acre)
2008	2	2600.65	2263.52	2937.79
2010	12	2281.15	1800.30	2762.00
2013	3	1417.86	1200.00	1635.72
2017	3	7045.46	6700.41	7390.50
2019	2	-793.15	-940.10	-646.20
Total	22			

4.2.3 Influential meta-analysis

The influence of each study can be estimated by deleting particular study from the analysis and noting the degree to which the size and significance of the treatment effect changes. The influence of individual studies on the summary effect estimate may be displayed. It helps us to identify the outliers among the studies. In this regard, data were computed with Influential meta-analysis and the results are depicted in Fig.4. Data indicated that the 20th study named Deshumukh study on turmeric influencing more on pooled estimate. Hence, the Drshmukh study may be possible outlier among the 27 studies.

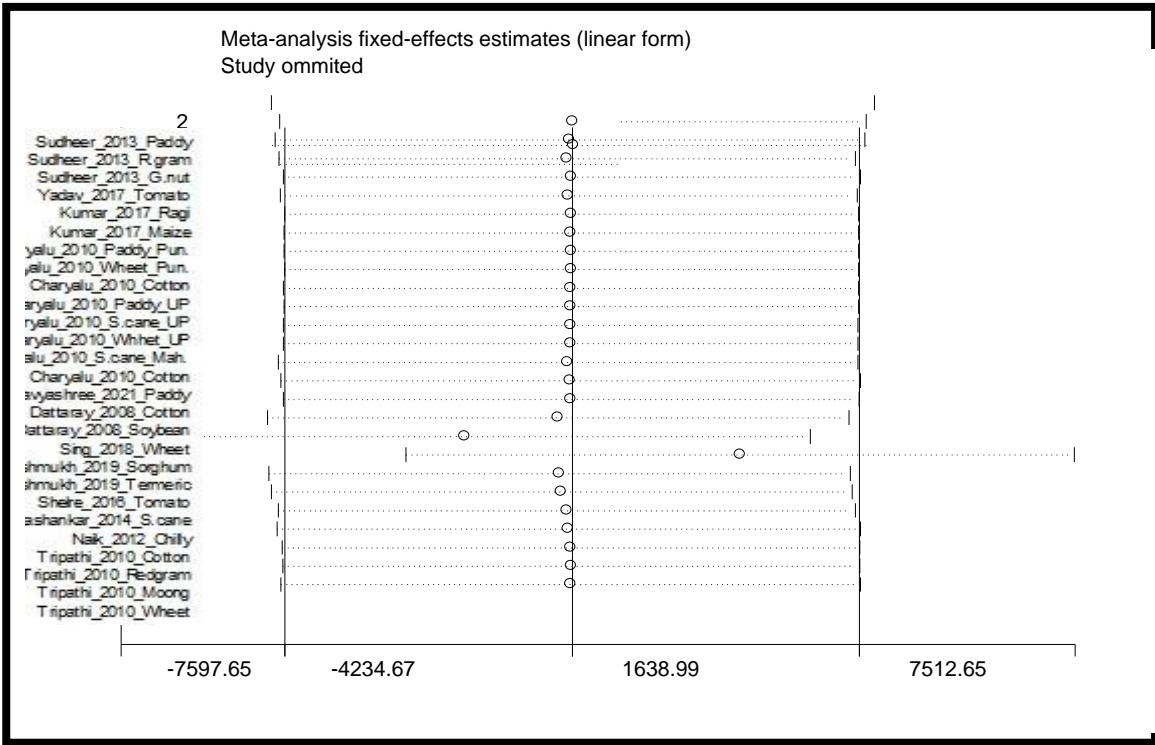


Fig. 4: Influential plot analysis

SUMMARY

V SUMMARY

Globally, in depth analyses like the United Nations-led International Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD), 2008, and the High Level Panel of Experts on Food Security and Nutrition (HLPE), 2019, have raised concerns about the current chemical and input intensive agricultural models. They have emphasised that continuing with agriculture as usual is no longer an option. Organic agriculture is a farming method that promotes the health of soils, ecosystems, and people. It is based on biological processes, biodiversity, and cycles that are tailored to local conditions, rather than the use of harmful inputs. Whereas, inorganic farming is an agriculture production method which involves the use of manmade products such as pesticides, herbicides, antibiotics, hormones and other chemical which are used to increase the rate of growth of crops.

India is deeply attached to organic agriculture. The government of India has pushed organic agriculture mostly through an export-focused strategy supported by a third-party certification system. This was a component of the National Programme for Organic Production (NPOP), which the Agricultural and Processed Food Products Export Development Authority (APEDA) of the Ministry of Commerce and Industry, Government of India, initiated during 2001. India is first in terms of the overall number of producers and ranks eighth in the world in terms of organic agricultural land. Only about 12 states, including Madhya Pradesh, Gujarat, Telangana, Sikkim, Bihar, Karnataka, Odisha, Rajasthan, Uttarakhand, Chhattisgarh, Tamil Nadu, and Uttar Pradesh, currently have their own state-level organic certification bodies that have been accredited by the Agricultural and Processed Food Products Export Development Authority (APEDA).

However, India has a long history of organic farming, has enormous potential to establish itself on both the national and worldwide markets, and immediate action must be taken to promote organic farming in order to boost exports. But there is little research and information on the economics of producing and marketing organic produce, or Organic Farming System(OFS) in comparison to inorganic produce, or Inorganic Farming System(IFS) generally. In fact, organic agriculture, according to one school of thinking, it

provides high-quality food while also improving an individual's health and the soil environment. As a result, the majority of state governments support organic farming. According to the second school of thinking, In organic agriculture, crop yields would be dramatically reduced in the early years, and farmers will not be able to earn remunerative rates for their produce. As a result, most farmers are conflicted about adopting organic farming as a regular practice. A single study only offers trustworthy data for a single location or time period. In this regard, Meta-analysis is a statistical technique which overcomes the limits of size or scope in single studies.

Therefore, an attempt is made to provide a basic understanding about the benefits of organic and inorganic agriculture across the country with a research project work entitled '**Profitability of organic agriculture in India – Meta Analysis**'. The broad objective of the present study is to find out the profitability of organic agriculture as compared to inorganic agriculture through an appropriate statistical model. The specific objectives of the study are given below:

- To estimate the profitability of organic agriculture in India through meta-analysis
- To apply advanced meta-analytical methods while estimating the profitability of organic agriculture in India

5.1 Type and plan of meta-analysis

The sources of search for literature in meta-analysis include the published literature, unpublished literature, uncompleted research reports and work in progress. Given a vast quantity of heterogeneous literature, suitable studies have to be located for a meta-analysis. In this regard, during literature search, initially located 50 potentially relevant articles written in English, published in journals and thesis were included. Based on inclusion and exclusion criteria, the located articles were screened for relevance and finally selected 27 studies for the present study purpose which includes 23 from Google Scholar and 4 from Krishi Kosha theses, match the inclusion requirements.

Data were extracted from the selected 27 studies on the items viz., Title of the selected study, First author, Year published, State, crop, Name of the Journal, Total no of

samples/sample size, Mean income of both Organic and inorganic agriculture. Further, data were extracted based on the Bootstrapping method. It is a method that can be used to find standard deviation and to construct a confidence interval for a statistic when the sample size is given. Data on the items of sample size and standard deviation of both organic and inorganic agriculture were extracted.

5.2 Statistical Methods in Meta-analysis

The statistical methods like Meta-analysis master sheet, Meta-analysis plots, Methods for pooling estimates, Fixed effect Model, Random Effect Model, Additional meta-analysis techniques including Cumulative meta-analysis, Influential meta-analysis and Sub group analysis were used in meta-analysis of selected 27 studies to provide a basic understanding about the benefits of organic and inorganic agriculture across the country.

5.3 Software for Statistical analysis

Statistical analyses are carried out with the aid of STATA statistical software version 2.0. STATA was used as an integrated suite for meta-analysis, cumulative meta-analysis, influential meta-analysis, subgroup analysis and graphical displays include Forest plot, and Funnel plot. STATA commands viz. meta, metacum and metainf were used for data processing, combining and estimating the pooled estimate.

5.4 Major findings of the study

5.4.1 Estimation of profitability of organic agriculture in India through meta-analysis

(a) Performance of organic agriculture from selected studies: Performance of organic agriculture in terms of mean income obtained ranges from Rs. 801.60/acre (P.Srikrishna Sudheer on redgram crop) to Rs.13799.20/acre (Durgesh Yadav's on tomato crop). Further, four studies indicated that negative gain from organic agriculture which is ranged from Rs.-8092.30/acre (M.S. Deshmukh et al on turmeric crop) to Rs.-1935/acre (D.Kumara charyalu et al on cotton crop).

(b) Overall profitability of organic agriculture from selected studies: Twenty-seven studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled

profit of organic agriculture (Rs.3850/acre) over inorganic agriculture in India provided by Random Effect Model. Estimated profit of organic agriculture (Rs.3850/acre) over inorganic agriculture of individual study represented by the size box corresponding to its magnitude, while the confidence interval of the estimator is represented by the arms of the box.

5.4.2 Advanced meta-analytical methods while estimating the profitability of organic agriculture in India

5.4.2.1 Cumulative meta-analysis: Twenty-seven studies used in Cumulative meta-analysis demonstrated the trend of the income of organic agriculture that is Rs.3850.00/acre in the study of Kavyashree (2021) on Paddy crop with lower estimate of Rs. 1613.07/acre and upper estimate of Rs. 6086.41 as compared to inorganic agriculture over the years. Income was less than pooled estimate in early years and further reduced over years and gradually increased and stabilized later to pooled estimate of Rs.3850.00 /acre.

5.4.2.2 Sub-group analysis

(a) Different regions: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different regions reveals that the mean estimated value for performance of organic agriculture was highest in South region (Rs.4332.54/acre) followed by West region (Rs. 3496.00/acre) and North region (Rs. 3327.03/acre).

(b) Different crops: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different crops indicates that the mean estimated value for performance of organic agriculture was highest in Sugarcane crop (Rs. 8135.57/acre) followed by Wheat crop (Rs. 5221.25/acre) and Cotton crop (Rs.2800.63/acre). However, it was observed that the negative gain was obtained in Paddy crop (Rs. -540.2/acre).

(c) Different states: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different states shows that the mean estimated value for performance of organic agriculture was highest in Karnataka (Rs. 7181.76/acre) followed by Maharashtra (Rs. 2757.80/acre), Punjab (Rs. 2417.00/acre), Andhra Pradesh (Rs. 1890.35/acre) and Uttar Pradesh (Rs.1049.67/acre).

(d) Different years: Mean estimate of performance of organic agriculture from selected studies through meta-analysis in different years reveals that the mean estimated value for performance of organic agriculture was highest in 2017 (Rs. 7045.46/acre) followed by 2008 (Rs.2600.66/acre), 2010 (Rs. 2281.16/acre) and 2013 (Rs.1417.87/acre). However, it was observed that the negative gain was obtained in 2019 (Rs. -793.15/acre).

5.4.3 Influential meta-analysis: The computed data with Influential meta-analysis indicates that the 20th study named Deshmukh's on Turmeric crop influencing more on pooled estimate. Hence, the 20th study may be possible outlier among the 27 studies.

5.5 Conclusion

From the study, the results are concluded as follows:

- Twenty-seven studies used in meta-analysis demonstrated significant heterogeneity leading to the pooled profit of organic agriculture (Rs.3850/acre) as compared to inorganic agriculture in India.
- In cumulative meta-analysis demonstrated the trend of the income of organic agriculture, compared to inorganic agriculture, less than pooled estimate in early years and further reduced over years and gradually increased and stabilized later to pooled estimate of Rs.3850.00 /acre.
- The mean estimated value for performance of organic agriculture was highest in South region (Rs.4332.54/acre).
- The mean estimated value for performance of organic agriculture was highest in Sugarcane (Rs. 8135.57/acre).
- The mean estimated value for performance of organic agriculture was highest in Karnataka (Rs. 7181.757/acre).
- The mean estimated value for performance of organic agriculture was highest in 2017 (Rs. 7045.46/acre).
- In influential meta-analysis, the 20th study named Deshmukh's on Turmeric crop influencing more on pooled estimate.

5.6 Future line of work

- Meta-analysis can also be used if yield data available for organic agriculture over inorganic agriculture.
- This study can be extended to horticultural crops if the studies on economics of organic and inorganic horticulture is available with appropriate tools to compute annual income.

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