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STATUS OF TAPIOCA IN MEGHALAYA STATE: AN ANALYSIS OF TRENDS, INSTABILITY AND DECOMPOSITION OF AREA, PRODUCTION AND PRODUCTIVITY

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ABSTRACT

Tapioca is a crucial tuber crop characterized by several positive attributes, including drought tolerance, adaptability, potential as a staple food, and various industrial applications. It holds substantial socio-economic significance, contributing to food and nutritional security in the state of Meghalaya. Notably, Meghalaya ranks prominently in India's tapioca production. The primary objective of this study is to analyze the growth, instability, and decomposition of tapioca production over the past 18 years, spanning from 2006 to 2023. The study is divided into two periods: 2006-07 to 2012-13 and 2013-14 to 2022-23. The findings indicate a gradual increase in both the area under cultivation and production of tapioca. Decomposition analysis reveals that the yield factor has been the most influential determinant of tapioca production in Meghalaya over the years, exerting a greater impact than both the area effect and interaction effect. Understanding the dynamics of production, area under cultivation, and yield is essential for effective policy formulation and program implementation, ensuring that necessary adjustments are made to optimize the crop's contribution to the region's agricultural and economic development.

Keywords: Compound growth rate, Cuddy-Della Valle Index, Decomposition analysis, Tapioca

Tapioca (*Manihot esculenta*), also known as cassava, is a vital tuber crop belonging to the family Euphorbiaceae. Due to its remarkable drought tolerance and adaptability to a wide range of adverse soil, nutrient, and management conditions, tapioca is considered an essential tropical tuber crop, often referred to as the "poor man's crop" (Sakthivel and Srikanth, 2020; Immanuel *et al.*, 2024). Its high carbohydrate content makes it a crucial staple food for over 500 million people worldwide (Blagbrough *et al.*, 2010). Additionally, tapioca is a rich source of energy, vitamins, fiber, and minerals (Zekarias *et al.*, 2019). Every part of the plant is utilized for various purposes, including food, feed, and fuel. It has become an integral part of local diets and traditional cuisines. The tuber is processed into products such as flour and dried chips, and the boiled tubers are often prepared in various dishes, including popular breakfast items. Furthermore, tapioca is rapidly emerging as a major industrial crop due to the increasing use of its flour and starch in various applications.

India ranks among the leading producers of tapioca, with a total production of 6,94,100 tonnes cultivated across an area of 1,83,000 hectares. Tamil Nadu is the largest tapioca producer in India, accounting for 38,93,240 tonnes (NHB, 2021). Other major tapioca-producing states include Kerala, Andhra Pradesh, Nagaland, Meghalaya, and Assam. In Meghalaya, both sweet and bitter varieties of tapioca are cultivated by tribal communities (Talang *et al.*, 2022). The state produces 35,979 tonnes of tapioca from an area of 5,463 hectares (Department of Agriculture, Meghalaya, 2023). Tapioca is grown through various production systems, including *Jhum* (traditional shifting cultivation), individual holdings, and homesteads. Small-scale farmers, particularly women, predominantly engage in tapioca cultivation. Tapioca plays a crucial role in food security and is an essential component of animal feed management in Meghalaya. The consumption of tapioca as a cereal substitute is particularly high in the state. Additionally, tapioca has significant socio-economic importance, contributing to the livelihood and economic upliftment of farmers. Given its prominence and importance in Meghalaya, it is vital to assess the production performance of this crop. However, no prior studies have focused on the growth patterns and instability of tapioca production in the state. Thus, the present study aims to examine the growth, instability, and decomposition of tapioca production in Meghalaya. Growth, instability, and decomposition analyses are essential indicators for evaluating production

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performance. A comprehensive assessment of these factors will provide valuable insights, guiding the development of strategies to minimize risks and foster further improvements in tapioca production.

MATERIALS AND METHODS

For this study, time-series data on the area, production, and productivity of tapioca were analyzed for the period from 2006-07 to 2022-23. The secondary data, sourced from the Department of Economics and Statistics and the Directorate of Horticulture, Government of Meghalaya, were publicly available. The state of Meghalaya consisted of 7 districts until 2012, after which the number of districts increased to 11. To account for the change in the number of districts over the study period, the analysis was divided into two phases: 2006-07 to 2012-13 and 2013-14 to 2022-23, ensuring a consistent comparison across both phases. The compound growth rate, instability analysis, and decomposition model were employed to examine the trends in tapioca production, area, and productivity.

Growth rate

The Compound Growth Rate (CGR) and Linear Growth Rate (LGR) are two commonly used methods for measuring growth rates in production. However, comparing growth rates between periods using the LGR method has limitations due to its inherent characteristics. Specifically, the LGR does not account for seasonal or cyclical variations and fails to capture the compound effects inherent in time series data (Dimashree *et al.*, 2023; Ayele *et al.*, 2021). Given these limitations, the adoption of the CGR method for comparing the growth rates of crop production, area, and productivity is more appropriate, as it more accurately reflects the compounded nature of growth over time.

Growth rate was estimated using Compound growth rate (CGR) and it was calculated as:

$$Y_t = ab^t u_t$$

where Y_t = area/production/productivity (Dependent Variable) in the time period t.

a = intercept

b^t = regression coefficient (1 + r)

t = years which takes value 1, 2, … …, n

u_t = error term for the year t

Taking logarithm to the both sides to transform the equation into log linear form for estimation:

$$log\ Y = loga + logb$$

The compound growth rate (r) of area, production and productivity in percentage was computed by using the function:

CAGR (r) (%) = {Antilog of (In b) – 1} × 100

Instability analysis

Agricultural instability, in terms of harvested area, production, and productivity, can be assessed using various analytical techniques. Three commonly employed methods are the Coefficient of Variation (CV), Cuddy-Della Valle Index (CDVI), and Coppock's Instability Index (CII) (Dimashree *et al.*, 2023). The CDVI refines the conventional CV by adjusting for trends over time, thereby providing a more accurate measure of instability. This method offers better insights into fluctuations in tapioca area, production, and productivity, effectively distinguishing between inherent variability and changes driven by trends (Cuddy and Della Valle, 1978). Compared to the CV, the CDVI is considered a more reliable measure of agricultural instability, as the variation captured by the CV can sometimes be overestimated (Anjum and Madhulika, 2018). The instability analysis was determined using Cuddy-Della Valle Index (CDVI). It was calculated as:

$$\text{Instability Index (Ix)} = CV \times \sqrt{1-R^2}$$

where, CV = coefficient of variation

R^2 = coefficient of determination

Decomposition analysis

Change in a crop's production is basically influenced by the harvested area under the crop and its average productivity. The relative contribution of harvested area, productivity and their interactions with overall tapioca production can be calculated using the decomposition analysis approach. The change in production was taken as the effect of three factors such as area factor, yield factor and interaction factor.

$$\Delta P = A_0\, \Delta Y + Y_0\, \Delta A + \Delta A \Delta Y$$

where, ΔP = change in production

ΔY = change in yield

ΔA = change in area

A_0 = area in the base year

Y_0 = yield in the base year

RESULTS AND DISCUSSION

Current status and growth rate

The area, production, and yield trends of tapioca in Meghalaya indicate a consistent annual increase over the study period (Table 1). Production rose from 20,870 tonnes in 2006-07, cultivated over 3,996 hectares, to 35,979 tonnes from 5,463 hectares in 2022-23. In 2022-23, the yield of tapioca in the state was 6.59 MT/ha, highlighting the potential for further yield improvement through targeted production interventions (Kharlyndo *et al.*, 2018). Tapioca is the second most widely cultivated tuber crop in Meghalaya, following potatoes, with the East Garo district being the largest producer, followed by West Garo, North Garo, and West Khasi. The East and West Jaintia districts have the least area under tapioca cultivation. The compound growth rate analysis reveals a steady increase in tapioca production from 2006-07 to 2022-23, with a growth rate of 2.27% in area, 4.29% in production, and 1.98% in productivity (Table 2). In Period I (2006-07 to 2012-13), Ribhoi district showed the highest growth rates, with 13.38% in area, 17.61% in production, and 3.73% in yield. In contrast, Jaintia Hills experienced significant declines, with area, production, and yield decreasing by -11.59%, -16.44%, and -5.48%, respectively. In Period II (2013-14 to 2022-23), the growth rate of tapioca cultivation areas saw notable increases, particularly in East Jaintia Hills (3.00%), followed by Ribhoi (2.24%) and West Jaintia Hills (2.12%). The highest growth rates in production (3.43%) and yield (4.35%) were observed in South West Khasi Hills. However, East Garo Hills saw a decline in area (-1.90%), production (-1.79%), and yield (-1.16%), while East Jaintia Hills also experienced negative growth in yield (-1.16%). These findings align with previous research by Kharlyndo *et al.* (2018). The overall growth rates for tapioca in Meghalaya were 2.27% in area, 4.29% in production, and 1.98% in yield (Table 3). The positive growth in tapioca production can be attributed to several factors, including increased preference among farmers, improved technical knowledge, and growing market demand, particularly from processing enterprises. Tapioca's widespread adoption in Meghalaya is also due to its suitability and adaptability to traditional farming systems and the social context of local farming communities. Meghalaya is known for its high consumption of cereal substitutes (Srinivasan and Anatharaman, 2005), and tapioca is a major crop for this purpose. As an essential crop for food security, livelihoods, and animal feed (Kharlyndo *et al.*, 2018), tapioca continues to be a key staple. However, declines in area and production have been noted in certain regions, particularly in East Garo Hills and Jaintia Hills, where increasing areas devoted to other crops and fluctuating market prices have affected cultivation. Similar findings have been reported by Shankar *et al.* (2021).

Instability Index

The instability index of tapioca across various districts in Meghalaya is presented in Table 4. During Period I, the overall instability index for the state showed a value of 5.25 for the area under cultivation, with production instability at 10.20 and yield instability at 4.55. Among the districts, Jaintia Hills, Ribhoi, and East Garo Hills experienced the highest instability in terms of area, with indices of 33.76, 14.71, and 6.66, respectively. In contrast, East Khasi Hills and West Khasi Hills exhibited the lowest levels of instability in area. In Period II, the instability index for area significantly reduced to 0.41, compared to the higher values observed in Period I. However, in Period II, districts such as East Jaintia Hills (6.53), West Jaintia Hills (4.76), and Ribhoi (4.03) exhibited higher instability

Table 1. Area, production and yield of tapioca in Meghalaya

Year	Area (ha)	Production (mt)	Yield (mt/ha)
2006-07	3996	20870	5.22
2007-08	4198	21938	5.23
2008-09	4187	21773	5.20
2009-10	4180	21152	5.06
2010-11	4180	21792	5.21
2011-12	4203	22046	5.25
2012-13	4983	29749	5.97
2013-14	5298	31947	6.03
2014-15	5349	32553	6.09
2015-16	5414	33304	6.15
2016-17	5392	35407	6.57
2017-18	5408	35528	6.57
2018-19	5416	35594	6.57
2019-20	5424	35658	6.57
2020-21	5433	35727	6.58
2021-22	5441	35789	6.58
2022-23	5463	35979	6.59

Source: Department of Economics and Statistics and Directorate of Horticulture, Government of Meghalaya

Table 2. Compound Growth Rate of tapioca in different districts of Meghalaya

District	Period I			Period II		
	Area (%)	Production (%)	Yield (%)	Area (%)	Production (%)	Yield (%)
Ribhoi	13.38	17.61	3.73	2.24	2.74	0.49
East Khasi Hills	0.64	2.91	2.25	1.55	2.75	1.18
West Khasi Hills	1.45	4.56	3.06	1.60	2.69	1.08
South West Khasi Hills	-	-	-	-0.88	3.43	4.35
Jaintia Hills	-11.59	-16.44	-5.48	-	-	-
East Jaintia Hills	-	-	-	3.00	1.81	-1.67
West Jaintia Hills	-	-	-	2.12	2.80	0.67
East Garo Hills	3.50	4.56	1.03	-1.90	-1.79	0.12
West Garo Hills	2.50	3.96	1.43	0.86	1.06	0.21
North Garo Hills	-	-	-	0.97	1.22	0.25
South West Garo Hills	-	-	-	1.80	3.12	1.30
South Garo Hills	0.53	2.68	2.14	0.09	3.26	3.17
Meghalaya	2.40	3.91	1.48	0.26	1.29	1.02

Source: Authors' calculations

Table 3. Compound growth rate of tapioca in Meghalaya

Period	Area (%)	Production (%)	Yield (%)
Period I (2006-07 to 2012-13)	2.40	3.91	1.48
Period II (2012-13 to 2022-23)	0.26	1.29	1.02
Overall (2006-07 to 2022-23)	2.27	4.29	1.98

in the area factor. Overall, the state and most districts displayed low instability in area, production, and yield throughout the study period, except during Period I, when Ribhoi experienced medium instability in area (17.60%), and Jaintia Hills showed high instability in both area (33.76%) and production (36.88%). The overall instability indices for tapioca are summarized in Table 5. During Period I, the instability indices for area, production, and yield were 5.25, 10.20, and 4.55, respectively. In contrast, Period II recorded much lower instability indices, with values of 0.41, 2.20 and 2.09 for area, production and yield, respectively.

The study indicates that tapioca production in Meghalaya exhibits low instability in both Period I and Period II, largely due to the region's favourable soil and climatic conditions, the crop's hardy nature, and its integration into diverse farming systems. Tapioca is well-suited for intercropping with various crops and thrives in different cultivation systems, such as *Jhum*, homesteads, farms, and gardens (Das and Singh, 2017). The availability of planting material in the region ensures a steady supply of the crop. Despite occasional damage from wild animals, tapioca demonstrates relative resistance to pests and diseases (Sakthivel and Srikanth, 2020), and no significant losses have been reported in the state. Furthermore, tapioca is a climate-resilient crop, with efficient stress-coping mechanisms that enable it to withstand adverse conditions such as drought, temperature extremes, soil acidity, and nutrient deficiencies (Jarvis *et al.*, 2012; Immanuel *et al.*, 2024).

Decomposition analysis

The analysis aimed to break down the variability in tapioca production into its individual components across two distinct time periods, and the results of this decomposition analysis are presented in Table 6. The findings indicate that in Period I, the area effect (58.06%) was the primary driver of tapioca production growth in Meghalaya. However, in Period II, the yield factor emerged as the dominant contributor, while the expansion of the cultivated area played a lesser role. This shift aligns with the observations of Kharlyndo *et al.* (2018), who reported that the productivity in the Jaintia districts was higher, with yields exceeding 10 t/ha. In districts such as East Jaintia Hills and East Garo Hills, the area effect had a much greater impact than the yield effect or the interaction effect.

Table 4. Instability index of tapioca in different districts of Meghalaya

District	Period I			Period II		
	Area	Production	Yield	Area	Production	Yield
Ribhoi	14.71	17.60	7.55	4.03	5.01	1.14
East Khasi Hills	3.02	10.04	6.65	2.86	5.23	2.50
West Khasi Hills	3.02	9.36	5.80	2.96	5.18	2.35
South West Khasi Hills	-	-	-	3.11	6.14	8.82
Jaintia Hills	33.76	36.88	6.33	-	-	-
East Jaintia Hills	-	-	-	6.53	4.80	2.91
West Jaintia Hills	-	-	-	3.92	4.99	1.53
East Garo Hills	6.66	9.52	2.66	4.76	4.71	7.96
West Garo Hills	5.66	12.01	6.56	1.65	2.05	0.62
North Garo Hills	-	-	-	1.77	2.28	0.70
South West Garo Hills	-	-	-	3.20	5.75	2.72
South Garo Hills	3.47	10.13	6.34	2.33	4.98	6.67
Meghalaya	5.25	10.20	4.55	0.41	2.20	2.09

Source: Authors' calculations

Overall, the area factor contributed most to production growth across the entire study period, although yield improvements also played a significant role (Table 7). During Period I, all districts experienced a dominant contribution from the area effect, which suggests significant expansion in the area under tapioca cultivation in the state. In contrast, Period II showed a higher contribution from the yield factor at the state level, although several districts, excluding South West Khasi Hills, still exhibited a high area effect in their decomposition analysis (Table 6).

The expansion in the area of cultivation is primarily driven by increased demand, favourable farming systems, and government schemes such as the Mission for Integrated Development of Horticulture (MIDH). The substantial contribution of the yield factor can be attributed to the region's ideal ecosystem, the availability of high-yielding local varieties, and the introduction of improved varieties. Research has shown that tapioca performs better at higher altitudes than at lower elevations (Ntawuruhunga *et al.*, 2007), and as a hill state, Meghalaya offers a conducive ecosystem for its cultivation. Government initiatives, such as the ICAR-CTCRI-NEH programme and the Tuber Crops Scheme, have facilitated the introduction of high-yielding varieties (HYVs), leading to both increased production and productivity. However, despite these positive developments, Meghalaya has yet to reach the average productivity level for tapioca seen across India. To further optimize production, it is imperative to continue research on varietal evaluation, the development of high-yielding varieties, and the adoption of modern agricultural technologies.

Challenges in tapioca production and marketing in Meghalaya

Tapioca (cassava) production and marketing in Meghalaya face several challenges that hinder its potential as a viable cash crop. One of the primary challenges is the unorganized and localized nature of cassava marketing, which is predominantly confined to village-level or nearby district markets. As a result, tapioca rarely reaches larger markets such as the state capital, Shillong, or neighboring states, limiting its demand and market expansion (Kharlyndoh *et al.*, 2018). The marketing chain is short, involving primarily farmers and small-scale aggregators or retailers, with no formal institutions in place to manage or support tapioca

Table 5. Instability index of tapioca in Meghalaya

Period	Area	Production	Yield
Period I (2006-07 to 2012-13)	5.25	10.20	4.55
Period II (2012-13 to 2022-23)	0.41	2.20	2.09
Overall (2006-07 to 2022-23)	5.58	8.40	3.85

Table 6. Decomposition analysis of tapioca in different districts of Meghalaya

District	Period I			Period II		
	Yield Factor	Area factor	Interaction Factor	Yield Factor	Area factor	Interaction Factor
Ribhoi	9.21	63.60	24.27	13.58	83.47	2.94
East Khasi Hills	17.50	23.31	5.41	40.59	53.60	5.81
West Khasi Hills	18.57	30.24	8.03	36.31	58.50	5.19
South West Khasi Hills	-	-	-	125.17	-17.73	-7.45
Jaintia Hills	-40.20	49.50	-12.12	-	-	-
East Jaintia Hills	-	-	-	-36.26	150.77	-14.51
West Jaintia Hills	-	-	-	18.85	76.87	4.28
East Garo Hills	6.18	74.73	6.97	-13.14	111.34	1.80
West Garo Hills	9.81	57.99	8.00	23.76	74.40	1.84
North Garo Hills	-	-	-	23.38	74.63	1.99
South West Garo Hills	-	-	-	39.12	54.42	6.47
South Garo Hills	16.71	23.78	5.20	81.00	14.78	4.21
Meghalaya	10.04	58.06	8.31	73.05	24.68	2.28

Source: Authors' calculations

marketing and distribution. Another constraint is the lack of available labour, which restricts the expansion of cassava cultivation. Many farmers struggle to allocate sufficient household labour to increase cultivated area, thus limiting the crop's growth potential. Additionally, tapioca farmers are not organized into cooperatives or associations, which reduces opportunities for collective action and better market access. Other significant constraints include the lack of improved tapioca varieties, limited knowledge of nutrient and disease management practices, price instability, and the absence of proper marketing and transportation infrastructure (Das and Singh, 2017). Furthermore, the absence of suitable tools or machinery for efficient cultivation and inadequate post-harvest management facilities severely limit both the overall productivity and profitability of tapioca cultivation (Das and Singh, 2017; Brahma *et al.*, 2022; Talang *et al.*, 2022).

Future prospects of tapioca production in Meghalaya

Tapioca is a promising and viable crop due to its adaptability, resilience, and significant potential for economic development. As farmers transition to settled agriculture, tapioca can be integrated into cropping systems, providing a reliable source of income due to its ability to thrive in poor soil and withstand drought conditions (Wilson *et al.*, 2017). The demand for tapioca spans domestic uses such as food, animal feed, and industrial applications as well as export markets. The tapioca market is projected to reach multimillion USD by 2029, presenting a substantial opportunity for diversification and value addition (Data Bridge Market Research, 2022). There is considerable potential for tapioca to be used in various forms, including value-added food products, sago production, and industrial chemicals like citric acid and high-fructose syrup. The increasing demand for tapioca offers an opportunity for farmers to enhance their incomes while contributing to local food security (Gabriel *et al.*, 2014; Adiele, 2020). Furthermore, the growing market demand for tapioca products can serve as an incentive for farmers to increase their cultivation, thereby strengthening their economic stability and enhancing food security.

Table 7. Decomposition analysis of tapioca in Meghalaya

Period	Yield Factor	Area Factor	Interaction Factor
Period I (2006-07 to 2012-13)	10.04	58.06	8.31
Period II (2012-13 to 2022-23)	73.05	24.68	2.28
Overall (2006-07 to 2022-23)	36.05	50.71	13.24

Efforts to enhance tapioca cultivation in Meghalaya should focus on developing formal market linkages, promoting farmer cooperatives, and expanding access to larger markets, including Shillong and neighboring states. Government intervention is essential to introduce crop-specific schemes, subsidies, and crop insurance, which will encourage increased cultivation and help stabilize farmers' incomes. Additionally, capacity-building initiatives should be prioritized to provide training on improved cultivation techniques, disease management, and sustainable farming practices, empowering farmers to enhance both productivity and resilience. Investing in post-harvest infrastructure, such as small-scale processing units for value-added products like chips, starch, and sago, can significantly boost the profitability of tapioca farming. Supporting local tapioca-based industries at the community or cottage level will help create additional income-generating opportunities and promote local economic development. Furthermore, organizations such as the Central Tuber Crops Research Institute (CTRI), Meghalaya Basin Development Authority (MBDA), and other local NGOs can play a crucial role in tapping into the full potential of this valuable crop by providing technical support, facilitating market access, and fostering community-driven initiatives.

CONCLUSION

The study conducted an empirical analysis of tapioca production performance and productivity variability in Meghalaya from 2006-07 to 2022-23, aiming to identify trends in the growth of area and production. The findings of this study will serve as a valuable resource for various stakeholders in formulating appropriate policies to maintain or enhance production while minimizing variability. Tapioca cultivation in Meghalaya demonstrated an overall positive trend, with consistent annual growth in both area and production. The instability analysis revealed a stable trend in the crop's performance. Decomposition analysis highlighted the significant roles of both yield and area effects in influencing production, suggesting that the region is well-suited for tapioca cultivation and has potential for further expansion in cultivation area. To ensure sustainable growth, efforts should be focused on addressing instability in specific districts, improving yield, and promoting the adoption of best agricultural practices. Additionally, future studies should explore the tapioca value chain, marketing channels, and advancements in genetics and breeding to further enhance the productivity and profitability of this crop.

Authors' contribution

Conceptualization of research work (AW, HND, TYT); Data collection (AW, HND,TYT); Statistical analysis (AW); Analysis of data and interpretation (AW, TYT, HND); Review of manuscript (AW, HND); Preparation of manuscript (AW, HND, TYT).

LITERATURE CITED

Adiele J G 2020. Intensive cassava production: Crop for the future. *Niger Agric J* **51**: 418-24.

Anjum S and Madhulika 2018. Growth and instability analysis in Indian agriculture. *Int J Multidiscip Res Dev* **5**: 119-25.

Ayele A, Worku M and Bekele Y 2021. Trends, instability and decomposition analysis of coffee production in Ethiopia (1993-2019). *Helion* **7**: 1-6.

Blagbrough I S, Bayoumi S A L, Rowan M G and Beeching J R 2010. Cassava: An appraisal of its phytochemistry and its biotechnological prospects. *Phytochem* **71**: 1940-51.

Brahma S, Upadhaya V, Nath R K, Sarma P and Sarma R 2022. Scope of cassava (*Manihot esculenta* Crantz) in improving livelihood of tribal people in rural areas of Kokrajhar district of Assam, India. *Pharm Innova* **11**: 1298-1302.

Cuddy J D A and Della Valle P A 1978. Measuring the instability of time series data. *Econ Stat* **40**: 79-85.

Das T K and Singh N A 2017. Indigenous tuber crops production system practiced by the tribe of West Garo hills district of Meghalaya. *Agric Ext J* **1**: 1-5.

Data Bridge Market Research 2022. *Global tapioca market – Industry trends and forecast to 2029*. Accessed on 09/10/2024 from https://www.databridgemarketresearch.com

Department of Agriculture, Government of Meghalaya. Available at: https://megagriculture.gov.in

Dimashree H, Mahendran K and Lavanya S M 2023. Status of pineapple in Manipur State: An analysis of trend, instability and decomposition of area, production and productivity. *Int J Stat Appl Math* **8**: 293-29.

Gabriel A A, Wijana S and Kumalaningsihn 2014. The design of integrated tapioca agro-industries development model. *J-PAL* **5:** 31-39.

ICAR-Central Tuber Crops Research Institute: Services Available at https://www.ctcri.org/neh.html

Immanuel S, Jaganathan D, Prakash P and Sivakumar S 2024. Cassava for food security, poverty reduction and climate resilience: A review. *Indian J Ecol* **51**: 21-31.

Jarvis A, Ramirez-Villegas J, Herrara C B V and Navarro R C 2012. Is cassava the answer to African climate change adaptation. *Trop Plant Biol* **5**: 9-29.

Kharlyndoh A, Anantharman M, Shanpru E and Naziri D 2018. Cassava production, marketing and utilization in Meghalaya, India: Results of a value chain assessment. Food Resilience through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+). International Potato Center (CIP). Laguna, Philippines.

N H B 2021. Area and production of horticulture crops: All India. Available at https://www.nhb.gov.in/

Ntawuruhunga P, Whyte J B A and Rubaihayo P 2007. Effect of altitude and plant age on cyanogenic potential, dry matter, starch and sugar content in cassava genotypes. Proceedings of the 13th ISTRC Symposium, 2007 pp. 177-85.

Sakthivel V and Srikanth A 2020. Factors influencing marketing behaviour of tapioca growers. *Plant Arch* **20**: 2494-96.

Shankar G R, Rajesh R and Selvam S 2021. A study on resource use efficiency and economic returns for Tapioca in Namakkal district of Tamil Nadu, India. *Pharm Innov* **10**: 400-04.

Srinivasan T and Anantharaman M 2005. *Cassava marketing system in India. Technical Bulletin Series: 43*. Central Tuber Crops Research Institute. Trivandrum, India.

Talang H D, Devi M B, Rymbai H, Biam K P, Rymbai P, Mawlong G and Hazarika S 2022. Tuber Crops: Problems and Prospects in Meghalaya. *Agric Environ E-Newsl* **3**: 69-78.

Wilson M C, Mutka A M, Hummel A W, Berry J, Chauhan R D, Vijayaraghavan A, Taylor N J, Voytas D F, Chitwood D H and Bart R S 2017. Gene expression atlas for the food security crop cassava. *New Phytol* **213**: 1632-41.

Zekarias T, Basa B and Herago T 2019. Medicinal, nutritional and anti-nutritional properties of Tapioca (*Manihot esculenta*): A review. *Acad Nutr* ***8***: 34-46.