**Contract farming in Gherkins production: Drivers of participation and production challenges**

**ABSTRACT**

Contract farming plays a vital role in the growth of horticultural crops in India, especially in gherkin cultivation by linking small and marginal farmers with agribusiness firms and exporters. The present study investigates the factors influencing the selection of the contract farming model and the constraints faced by farmers in gherkins cultivation, marketing and contractual arrangements. Data were collected from 120 contract farmers of Ballari and Haveri districts of Karnataka through random sampling using a pre-tested, well-structured schedule and analysed using the Rank Based Quotient (RBQ) method. The findings reveal that remunerative prices (RBQ 81.00) were the most influential factor in farmers' decision to opt for contract farming, followed by the buyback agreement (RBQ 74.00), input supply, technical assistance and transportation facilities. These factors highlight the importance of financial incentives, market assurance and logistical and technical support in promoting contract farming. In terms of production constraints, adverse weather conditions (RBQ 91.29) ranked highest, followed by anthracnose and viral diseases (RBQ 87.95), fruit fly infestation and labour scarcity. Marketing-related challenges included difficulty in meeting quality standards (RBQ 85.42) and the absence of a domestic market (RBQ 76.11), indicating the vulnerability of farmers to export market dependencies and strict quality norms. Contractual challenges were also prominent, with no compensation for crop loss (RBQ 85.36) and high input costs (RBQ 79.52) being major issues. The study suggests the need for risk-sharing mechanisms, input subsidies, quality technical services and transparent contractual practices to ensure the long-term sustainability and profitability of gherkin contract farming. These insights are crucial for policymakers, agribusiness firms and stakeholders aiming to improve the effectiveness of contract farming models in India.

**Keywords**: Agribusiness; Constraints; Rank Based Quotient; Sustainability

1. **INTRODUCTION**

India is among the top global producers of gherkins, contributing significantly to the international supply. India has emerged as a global leader in horticulture, ranking second in the world in the production of fruits and vegetables. The horticulture sector plays a vital role in the Indian economy by contributing significantly to agricultural GDP, ensuring food and nutritional security and generating employment and export earnings. According to the Ministry of Agriculture and Farmers Welfare (2023–24), India produced over 355 million tonnes of horticultural crops from an area of approximately 28 million hectares. Major horticultural crops include fruits, vegetables, flowers, spices, plantation crops and medicinal and aromatic plants (Anonymous, 2024). Contract farming plays a vital role in the growth of horticultural crops in India, especially in gherkin cultivation by linking small and marginal farmers with agribusiness firms and exporters. It ensures assured markets, better prices and access to quality inputs and technical guidance, which are especially important for perishable crops like fruits and vegetables. This system reduces marketing risks, promotes good agricultural practices, and enhances export potential, particularly in crops like gherkins, grapes and chillies. In India, where horticulture faces challenges like post-harvest losses and price volatility, contract farming provides a structured approach to improve productivity, income stability and integration into global value chains. Government initiatives such as the National Horticulture Mission (NHM) and the Mission for Integrated Development of Horticulture (MIDH), the sector foster innovation, enhance productivity and promote sustainable practices in horticulture.

Gherkins (*Cucumis aguria*), also known as bur gherkins or West Indian gherkins, are annual trailing vines belonging to the gourd family, prized for their edible fruit. Native to Southern Africa, gherkins thrive in warm climates and are primarily cultivated in Karnataka, Tamil Nadu, Andhra Pradesh and Telangana in India. The crop requires well-drained red sandy loam soil with a pH of 6.5 to 7.5 and is typically grown on small plots due to its intensive labour demands, including frequent irrigation and vigilant pest management (APEDA). Originally prompted by high production costs in Europe, which shifted cultivation to Turkey and then to India, gherkins are almost entirely exported, particularly to European countries and the USA, where they are a dietary staple. Harvested by hand and processed quickly after picking, gherkins undergo pickling using methods like brine fermentation or vinegar brining, enhancing their tangy flavour and extending shelf life. Beyond their culinary use as a popular condiment in sandwiches, salads and burgers, gherkins are valued for their nutritional benefits, contributing to their increasing global demand as a versatile and healthy snack (Indian Gherkins Exporters Association, Bangalore).

India dominates the global gherkin market as the largest producer and exporter, contributing significantly to agricultural exports (Gunadal et al., 2024). With a production concentrated mainly in Karnataka, Tamil Nadu, Andhra Pradesh, and Telangana, India accounted for 15 per cent of global production and 25-27 per cent of global exports in recent years. During the financial year 2024, India exported 244,243.54 MT and earned $256.58 million 2024 (Anonymous, 2024). The sector engages around 90,000 small and marginal farmers across 65,000 acres, with production yields averaging 7.43 metric tonnes per acre per crop. Gherkins are primarily exported to over 20 countries, including major markets like the USA, European nations and Australia (APEDA). The industry not only bolsters rural employment but also adheres to international quality standards, with processing plants certified by ISO, BRC, IFS, FSSC-22000, and HACCP, ensuring product safety and meeting global demand for both bulk industrial use and consumer-ready packs. APEDA's support has been pivotal in infrastructure development, quality enhancement and market promotion, further consolidating India's position as a key player in the global gherkins trade. Despite being the world's leading producer and exporter of gherkins, India faces several challenges related to production, such as high input costs, climate sensitivity and quality control, as well as marketing issues like price fluctuations, limited market access for smallholders and dependency on international buyers. In this context, the present study seeks to investigate the key factors motivating farmers to opt for contract farming and focuses on identifying the major challenges encountered by farmers in the cultivation and marketing of gherkins in India, including agronomic, financial and market-related issues.

1. **METHODOLOGY**

The study was purely based on primary data. Based on the highest area under gherkins, Karnataka state was selected. In Karnataka, major gherkin-cultivating districts are Ballari, Koppal, Haveri, Davanagere and Chitradurga. On the basis of maximum area and production of gherkins, two top districts, viz, Ballari and Haveri (Table 1) districts are selected for the study to work out the Rank Based Quotient (RBQ) of gherkins under contract farming. Ballari and Haveri districts were ranked first (635.80 ha and 11207.40 MT) and third (125.80 ha and 2375.40 MT) in the area under gherkins cultivation and quantity produced respectively in the state of Karnataka [Five year averages of area and production of gherkins (2015-16 to 2019-20) were considered, State Department of Horticulture, GoK].

To study the factors driving farmers towards gherkins production under contract farming, a multistage sampling technique was adopted for the selection of respondents for the study. In the first stage, Karnataka state was purposively selected, as it is the topmost gherkin-producing and exporting state in the country. In the second stage, from Karnataka state, two districts, viz, Ballari and Haveri, were purposively chosen based on the area and production of gherkins in the past five years. In the next stage, from each of these selected districts, 60 gherkin-growing contract farmers were randomly selected to have a total sample size of 120 respondents for the study. The data were collected by a personal interview method using a well-structured pre-tested schedule from selected respondents from the study districts to meet the economics of gherkins production under contract farming objective of the study.

Descriptive statistics provide simple summaries about the sample and about the observations that have been made. It deals with the presentation of numerical facts or data in either tables or graph form and with the methodology of analysing the data. Rank-Based Quotient (RBQ) was used to quantify the data collected by the preferential ranking technique. The process starts by first ranking the parameters and then calculating the Rank Based Quotient (RBQ), the methodology adopted by M Kaleeswaran *et al.,* (2024).

RBQ =

Where,

fi = number of farmers reporting a particular problem under ith rank.

N = Numbers of farmers.

n = numbers of problems identified.

The results of RBQ can be inferred as if the particular constraint showing highest RBQ value then it is considered as the most problematic constraints with superior rank and lesser the RBQ value reveals the less ranked constraints.

**Table 1: District-wise five-year average area, production and productivity of gherkins crop in Karnataka (2015-16 to 2019-20)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **District name** | **Area****(Ha)** | **Production****(M. Tonnes)** | **Yield****(M. Tonnes/Ha)** |
| 1 | Bengaluru Urban | 26.80 | 804.20 | 17.91 |
| 2 | Bengaluru Rural | 79.00 | 1253.40 | 11.71 |
| 3 | Chikkaballapura | 26.25 | 454.50 | 13.02 |
| 4 | Chitradurga | 93.20 | 852.60 | 6.50 |
| 5 | Davanagere | 101.00 | 426.20 | 8.09 |
| 6 | Kolar | 60.60 | 1893.20 | 27.86 |
| 7 | Ramanagara | 0.60 | 10.60 | 3.60 |
| 8 | Shivamogga | 0.40 | 9.00 | 8.00 |
| 9 | Tumakuru | 32.80 | 474.20 | 5.92 |
| 10 | Bagalakote | 0.00 | 0.00 | 0.00 |
| 11 | Belagavi | 7.20 | 154.20 | 17.38 |
| 12 | Vijayapura | 0.00 | 0.00 | 0.00 |
| 13 | Dharwad | 0.60 | 11.40 | 3.49 |
| 14 | Gadag | 1.09 | 9.20 | 1.67 |
| **15** | **Haveri** | **125.80** | **2375.40** | **14.86** |
| 16 | Uttara Kannada | 1.60 | 57.00 | 20.07 |
| **17** | **Ballari** | **635.80** | **11207.40** | **17.49** |
| 18 | Bidar | 57.40 | 614.20 | 11.60 |
| 19 | Kalaburagi | 0.00 | 0.00 | 0.00 |
| 20 | Koppal | 150.60 | 2883.40 | 16.53 |
| 21 | Raichur | 0.00 | 0.00 | 0.00 |
| 22 | Yadagiri | 1.00 | 7.00 | 1.40 |
| 23 | Chamarajanagara | 4.60 | 95.00 | 16.50 |
| 24 | Chikkamagalur | 60.00 | 1185.60 | 17.94 |
| 25 | Dakshina Kannada | 85.40 | 3112.20 | 14.59 |
| 26 | Hassan | 39.40 | 1345.60 | 15.71 |
| 27 | Kodagu | 0.00 | 0.00 | 0.00 |
| 28 | Mandya | 77.60 | 1967.80 | 25.18 |
| 29 | Mysuru | 24.60 | 353.00 | 12.40 |
| 30 | Udupi | 21.65 | 730.00 | 17.80 |
|   | **State Total** | **1714.99** | **32286.30** | **10.91** |

*Source: Department of Horticulture. Government of Karnataka, 2015-16 to 2019-20.*

1. **RESULT AND DISCUSSION**

**3.1 Factors influencing farmers’ selection of contract farming models**

By evaluating opinions, factors influencing farmers’ selection of the contract farming model were identified. Factors were analysed by using the Rank Based Quotient (RBQ) technique, and results are presented in Table 2 along with the RBQ values. This remunerative price factor has the highest RBQ value of 81.00, indicating its significant importance to farmers. Remunerative prices ensure that farmers receive fair compensation for their produce, which directly influences their livelihood and profitability. So that farmers used to be influenced by this factor and go for gherkin cultivation under the contract farming model. With an RBQ value of 74.00, the buyback agreement is also considered crucial. Such agreements provide farmers with a guaranteed market for their produce, reducing uncertainty and ensuring a steady income stream. This helps farmers to come out of the marketing risk so that they prefer contract farming.

Input supply has an RBQ value of 59.50, indicating its importance in agricultural operations. Access to quality inputs such as seeds, fertilisers and pesticides is essential for optimising crop yields and quality. This timely technical assistance factor, with an RBQ value of 47.83, underscores the importance of timely and effective technical support for farmers. Technical assistance regarding crop management, pest control and other agricultural practices can significantly impact productivity and profitability. The company provides technical assistance when and where required, and the field supervisor usually used to visits fields on a regular basis to monitor the crop and give advice to farmers about the agricultural operations. Finally, the transportation facility has an RBQ value of 37.50. Adequate transportation infrastructure is crucial for enabling farmers to efficiently transport their produce to markets or processing facilities. It plays a vital role in reducing post-harvest losses and ensuring the timely delivery of goods. By providing transportation facilities, it cuts down the marketing costs to contract farmers. By entering into contract farming, farmers will save the marketing costs and time. The RBQ values provide insights into the relative importance of each factor, highlighting areas where interventions or improvements can have the most significant impact on agricultural outcomes and farmer welfare.

**Table 2: Factors influencing farmers’ selection of contract farming**

(n=120)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Factors** | **RBQ Value** | **Rank** |
| 1 | Remunerative prices | 81.00 | I |
| 2 | Buyback agreement | 74.00 | II |
| 3 | Input supply | 59.50 | III |
| 4 | Timely technical assistance | 47.83 | IV |
| 5 | Transportation facility | 37.50 | V |

*Note: RBQ- Rank-Based Quotient*

**3.2 Constraints faced by contract farmers in the production of gherkins**

The constraints faced by contract farmers in gherkin cultivation, as highlighted in Table 3, provide critical insights into the challenges impacting production under contract farming arrangements. Adverse weather conditions emerge as the most significant constraint, with a high RBQ value of 91.29. Unfavourable weather, such as excessive rainfall or drought, can adversely affect gherkins' growth and yield, leading to production losses. Climate variability and unpredictability are known challenges in agriculture (Lemi and Hailu, 2019). High incidence of anthracnose and viral diseases ranks prominently as a constraint (RBQ 87.95). Diseases can devastate gherkin crops, reducing yield and quality. Effective disease management strategies, including resistant varieties and integrated pest management, are essential to mitigate these risks (Melchers and Stuiver, 2000). Heavy incidence of fruit flies poses a significant challenge (RBQ 80.08). Fruit flies can cause extensive damage by feeding on gherkins, leading to yield losses. Integrated pest management practices and timely interventions are crucial to minimise fruit fly impacts (Khan *et al.,* 2017).

The scarcity of skilled labour is a notable constraint (RBQ 71.44). Skilled labour shortages can hinder efficient farming operations, including timely planting, harvesting, and pest management. Training programs and incentives may be necessary to address this issue. The occurrence of misshapen fruits, such as crooked-necked gherkins, is another significant challenge (RBQ 63.48). This can affect marketability and consumer acceptance, impacting farmer income. Proper crop management practices and varietal selection can help mitigate this issue (Witcombe *et al.,* 1996). Water scarcity poses a moderate constraint (RBQ 54.92). Adequate water availability is crucial for gherkin growth and development. Efficient irrigation systems and water management practices are essential to optimise water use efficiency. The high cost of inputs, including seeds, fertilisers, and pesticides, is a notable but less severe constraint (RBQ 22.58). Input costs can impact profitability, especially for smallholder farmers. Access to affordable inputs and subsidies can help alleviate this burden. The constraint of inadequate availability of quality seedlings is identified as a lower priority issue (RBQ 18.71). Quality seedlings are essential for uniform crop establishment and yield potential. Improved seed distribution systems and seed quality standards can address this challenge (Nabuuma *et al.,* 2022).

The constraints identified underscore the complex challenges faced by contract farmers in gherkin cultivation. Adverse weather conditions and disease outbreaks represent acute risks that can significantly impact production and profitability. Issues such as fruit fly infestations, scarcity of skilled labour, and misshapen fruits further underscore the multifaceted nature of challenges in agricultural production under contract farming.

**Table 3: Constraints faced by contract farmers in the production of gherkins**

(n=120)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Factors** | **RBQ Value** | **Rank** |
| 1 | Adverse weather conditions | 91.29 | I |
| 2 | Heavy incidence of anthracnose and viral diseases | 87.95 | II |
| 3 | Heavy incidence of fruit flies | 80.08 | III |
| 4 | Scarcity of skilled labour | 71.44 | IV |
| 5 | Misshaped fruits (Crook neck shaped fruits) | 63.48 | V |
| 6 | Scarcity of water | 54.92 | VI |
| 7 | Difficulties in following package of practice | 45.45 | VII |
| 8 | High cost of structure frame | 36.06 | VIII |
| 9 | High perishability nature of fruits | 28.03 | IX |
| 10 | High cost of inputs | 22.58 | X |
| 11 | Lack of quality seedlings | 18.71 | XI |

*Note: RBQ- Rank Based Quotient*

Addressing these constraints requires integrated approaches that combine agronomic practices, pest and disease management strategies, improved irrigation systems, and support for labour availability and training. Contract farming models can play a crucial role in mitigating risks by providing technical support, access to inputs, and market linkages that enhance farmer resilience and sustainability.

**3.3 Constraints faced by contract farmers in the marketing of gherkins**

The constraints faced by contract farmers in the marketing of gherkins, as identified through the Rank Based Quotient (RBQ) technique and presented in Table 4, highlight significant challenges that impact the commercial aspects of gherkins production under contract farming. The foremost challenge identified by farmers is the difficulty in meeting quality requirements (RBQ 85.42). Quality standards are crucial in agri-business contracts, especially for export-oriented crops like gherkins. Failure to meet these standards can lead to rejected produce or lower prices, affecting farmer incomes and contractual relationships. The absence of a domestic market is another significant constraint (RBQ 76.11). Contract farming often focuses on export markets or specific buyer requirements, leaving farmers vulnerable to market fluctuations and limited local selling opportunities. This dependency on export markets can expose farmers to external economic risks (Kareem O. I.*,* 2016). Farmers also face challenges due to limited options in choosing contract partners (RBQ 64.58). This constraint restricts farmers' ability to negotiate terms and conditions, potentially leading to less favourable contractual agreements or reduced market access. Diversifying contract partnerships can enhance market resilience and bargaining power (Pittz *et al,* 2024).

Lack of sufficient market information poses a substantial challenge (RBQ 52.50). Farmers may struggle to anticipate market demand, pricing trends, and competitor activities, which are crucial for making informed decisions in marketing their produce effectively. Delayed payments by the contracting company represent a significant financial constraint (RBQ 45.56). Timely cash flow is critical for farmers to cover production costs and sustain their operations. Delays can strain farmer finances and erode trust in contract farming arrangements (Vikash *et al,* 2022). Issues related to faulty weighing by the company also emerge as a notable concern (RBQ 42.50). Accurate weighing is crucial as it directly impacts farmers' earnings based on the quantity of produce delivered. Such discrepancies can lead to disputes and undermine farmer-company relations (Key *et al.,* 1999).

Strengthening quality control measures and providing farmers with training and support to meet stringent quality standards can enhance market competitiveness and reduce rejection rates. Enhancing access to market information through training programs, farmer cooperatives, or digital platforms can empower farmers to make informed decisions and navigate market uncertainties more effectively. Ensuring transparent and timely payment practices, as well as accurate weighment processes, is crucial for building trust and maintaining positive relationships between farmers and contracting companies.

**Table 4: Constraints faced by contract farmers in marketing of gherkins**

(n=120)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Factors** | **RBQ Value** | **Rank** |
| 1 | Difficulty in meeting the quality requirement | 85.42 | I |
| 2 | No domestic market | 76.11 | II |
| 3 | Limited choice of contract partners | 64.58 | III |
| 4 | Inadequate market information | 52.50 | IV |
| 5 | Delayed payment by the company | 45.56 | V |
| 6 | Faulty weighing by the company | 42.50 | VI |

*Note: RBQ- Rank-Based Quotient*

**3.4 Constraints faced by farmers in contract farming**

The constraints faced by contract farmers in gherkins cultivation under contract farming, as analysed using the Rank Based Quotient (RBQ) method and presented in Table 5, shed light on critical challenges that impact the contractual relationships and operational dynamics in gherkins production.

The foremost constraint highlighted by contract farmers is the lack of compensation for crop loss (RBQ 85.36). This issue is particularly significant as it directly impacts farmers' financial security and risk management strategies. Contract farming agreements typically outline responsibilities for both parties, including provisions for risk-sharing in case of crop failures or losses (Meuwissen *et al.,* 2019). High costs of input materials represent a major challenge (RBQ 79.52). Inputs such as fertilisers, pesticides and seeds constitute a substantial portion of production expenses for farmers. High input costs can reduce profitability and economic viability, especially for smallholder farmers (Lipok *et al.,* 2023). The cost of planting materials is identified as another significant constraint (RBQ 63.69). Quality planting materials, including seeds and seedlings, are crucial for crop establishment and yield potential. Affordable access to quality planting materials is essential to ensure productivity and profitability in contract farming.

Farmers perceive manipulation of contractual norms by the company as a notable challenge (RBQ 52.29). Contract farming agreements should provide clear guidelines and fair practices to protect the interests of farmers. Transparency and adherence to agreed-upon terms are crucial for maintaining trust and fostering sustainable partnerships (Prasenjit Barik, 2021). The absence of adequate technical assistance was identified as a significant constraint (RBQ 47.38). Contract farming models typically include provisions for technical support to enhance farmer productivity and adherence to quality standards. Improved extension services and training programs can address knowledge gaps and improve farm management practices (Arouna *et al,* 2021). The rejection rate of produce by the company is a concern for contract farmers (RBQ 36.67). Product rejection can lead to financial losses and affect farmers confidence in the reliability of the contract farming arrangement. Clear communication on quality standards and collaborative efforts to meet market requirements are essential to minimise rejection rates (Vikash *et al,* 2022). The lapse of agreements between farmers and companies is identified as a lower priority constraint (RBQ 28.10). Contract duration and renewal terms are critical aspects of contract farming agreements. Ensuring continuity and stability in contractual relationships can provide farmers with security and predictability (Pittz *et al,* 2024).

**Table 5: Constraints faced by farmers in contract farming**

(n=120)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Factors** | **RBQ Value** | **Rank** |
| 1 | No compensation for crop loss | 85.36 | I |
| 2 | High input cost (Chemical fertilisers & PPC) | 79.52 | II |
| 3 | High planting material cost | 63.69 | III |
| 4 | Manipulation of norms by the company | 59.29 | IV |
| 5 | lack of technical assistance | 47.38 | V |
| 6 | High rejection rate by the company | 36.67 | VI |
| 7 | Lapse of agreement | 28.10 | VII |

*Note: RBQ- Rank-Based Quotient*

Establishing mechanisms for compensating farmers for crop losses can enhance risk management and financial stability in contract farming agreements. Facilitating access to affordable and quality agricultural inputs through subsidies, cooperative arrangements, or bulk purchasing initiatives can alleviate financial burdens on farmers. Ensuring transparency in contractual norms and practices and promoting adherence to agreed-upon terms, can mitigate issues related to manipulation and disputes. Strengthening technical assistance, extension services, and farmer training programs can enhance productivity, improve quality standards, and empower farmers to navigate challenges effectively.

1. **CONCLUSION**

The farmers in the research area, practising gherkins cultivation under contract farming, were influenced by remunerative prices for gherkins, followed by buyback agreements, input supply, and timely technical assistance by the company and transportation facility provided by the company. The farmers faced adverse weather conditions, Heavy incidence of anthracnose and viral diseases, heavy incidence of fruit flies, scarcity of skilled labourers, misshapen fruits and scarcity of water were the serious problems in the production of gherkins. The major marketing constraints faced by the gherkin farmers in the marketing of gherkins in the study area were difficulty in meeting quality requirements, no domestic market for gherkins in India, limited choice of contract partners, inadequate market information, delayed payment by the company and faulty weighment by the company. No compensation for crop loss, high input cost (Chemical fertilisers & PPC), high planting material cost, manipulation of norms by the company, lack of technical assistance, high rejection rate by the company and lapse of agreement were the major constraints faced by the gherkins growers in contract farming in the study region.

The study's findings suggest several important policy implications to strengthen gherkin contract farming in India. To protect farmers from price manipulation, price assurance mechanisms similar to Minimum Support Price (MSP) and standardised, legally enforceable contract agreements should be promoted. A dedicated regulatory body at the district or state level is needed to monitor contract farming operations and address grievances. Companies must be mandated to supply timely inputs and technical support, particularly to manage pests and diseases such as anthracnose and fruit flies, while public-private partnerships should work toward developing resistant varieties and promoting integrated pest and disease management. Customised crop insurance schemes and mandatory compensation clauses should be introduced to safeguard farmers against weather-related losses and unfair rejection of produce. Marketing infrastructure, including fair weighing systems and grading facilities, must be upgraded, and a centralised information platform should provide market data and contract options to farmers. To address labour and water shortages, the promotion of mechanisation and water-saving irrigation technologies like drip systems is essential. Efforts should also be made to develop domestic markets for gherkins through awareness, value-addition initiatives and timely payment to farmers must be enforced through penalties for delays, and local-level dispute resolution mechanisms involving stakeholders should be established to ensure transparency and fairness in contract enforcement.

**Disclaimer (Artificial intelligence)**

Option 1:

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

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