Amaravati: Future Food Processing Hub of India

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Abstract

Andhra Pradesh’s bifurcation in 2014 required the creation of an new capital—and presented a unique opportunity to draft a blue print for a city that could be a model for urban development across India and around the world. To begin the journey from farmland to world-class city, more than 24,000 farmers and other land owners in 29 villages near Vijayawada and Guntur agreed to pool 217 sqkm where the new capital will be built from the ground up.

Keywords: Agriculture, Food processing, Amaravathi, Value chain, Food Parks

I. Introduction

I.i. Food processing in India

Food processing is a critical growth and employment engine for India, Andhra Pradesh and Amaravati. The nation is a global powerhouse for agriculture and food processing, ranking fifth overall in exports, production and consumption, second in fruit and vegetable production (10% of world production) and first in terms of milk production (27% of world production).

Generating more than INR 845 billion annually in 2012–13 (at 2004–05 prices), the food processing industry grew at a compound annual rate of about 8.4% from 2008 to 2013, and is projected to grow by 15% in each of the next 5 years. India processes less than 2% of its fruit and vegetable products, compared with 70 to 80% in other developing countries such as Brazil, Malaysia and the Philippines, indicating a lot of headroom for growth. Having identified food processing as one of 25 critical focus sectors in the ‘Make in India’ campaign, the Government allows 100% foreign direct investment in automating processing for most food products. The Government has also announced a special corpus of INR 2,000 crore in the financial year 2015–16 in NABARD for extending affordable credit to food parks and processing units in these parks.

Agriculture and food processing provide more than half of the jobs in India. Food
processing is especially labour-intensive, creating 13% of jobs – the most amongst all manufacturing industries. The sector generates 30–80 jobs per acre depending on type and level of mechanisation of food processing units. Patanjali Food and Herbal Park in Haridwar spans about 95 acres and is anticipated to provide direct employment for more than 7,000 people at full operation. Agro-based industries, such as food-processing parks, not only bring industry to rural areas but also improve farmers’ access to the broader market, increasing their incomes. Andhra Pradesh, known as the ‘Rice Bowl of India’, is a leading state for agriculture and food processing. It ranks in the top five for the production of rice, maize, tomatoes, sunflower, mango, sugarcane, jowar and pulses such as sarhar, tur and gram. Andhra Pradesh enjoys diverse climate with five agro-climatic zones and 8.45 million hectares of net cultivable area and fertile river systems of Godavari, Krishna, Tungabhadra, Vamsadhara and Penna. The combination of natural endowments and developed infrastructure, irrigation systems, utilities and manpower (for example, Andhra Pradesh has a 70% literacy rate, 58 agricultural research stations and one sugar cane research station) make this a favoured state for food processors in the country. With the region’s many advantages, Amaravati can emerge as a hub for processing the top crops in the region including sugarcane, rice, tomato, maize and mango. It could focus opportunistically on other surplus crops including banana, lemon, brinjal, pulses, groundnut, coconut, and cabbage. In the long term, Amaravati is envisioned as a hub for new-age agriculture and food processing driving productivity improvements and innovations for India and Asia. The long-term goal of the city is to emerge as the region’s top destination for research and development, training and implementation in progressive agricultural practices such as greenhouse farming, precision farming, vertical farming, festination, hydroponics and automation. The importance of food processing as a sector lies not only in its attractiveness and opportunity, but also in its ability to share the benefits of urbanisation across all segments of society in line with the city’s vision of inclusive development.

II.ii. Food processing segments and focus for Amaravati

Food processing is typically segmented on the basis of product type and processing stage. The industry includes a range of archetypes and players depending on type of product and step in the value chain.

II.iii. Product type segmentation

Processed foods can be divided into six major product families:
Grains and oil seeds: This largest segment in food processing generates revenues of about INR 355,000 crore in 2012, nearly half of the food processing industry. This includes production of staples such as flour, rice, grains, pulses, breakfast cereals,
and ready-mix flours (idli, dosa, gulabjamun). Expected to grow at an annual rate of 16% from 2012–17, this is a highly fragmented segment – organised players produce less than 20% of the sector’s output, although their share should increase with the entry and growth of fast-moving consumer goods players such as LT Foods, Kohinoor, Bunge, Cargill, and ITC. Given the high availability of grains and pulses such as maize, rice, moong, urad, jowar, castor, and rice, this could be a strong focus segment for Amaravati. (Guntur is India’s #3 districts for maize, moong, jowar and urad; Krishna is #3 in India for Urad.)

Packaged foods: Revenues in this segment, the second-largest in food processing, amounted to about INR 203,000 crore in 2012, or nearly 28% of food processing. Products include spices, snacks and savouries, ready-to-eat and ready-to-cook meals, and confectioneries including chocolates, biscuits and bakery items. As consumers earn more and have less time for shopping and cooking, the segment is estimated to grow by more than 15% annually from 2012–17. More than 30% of the sector is dominated by large companies such as ITC, Dabur, Britannia, and Mondelez. Proximity to raw materials and downstream contracted processors are advantages which make Amaravati an attractive destination for this segment.

Milk and milk products: With revenues of about INR 87,000 crore in 2012, 12% of the overall processing industry, the dairy sector includes pasteurised milk, milk powder, ice cream powder, condensed milk, infant foods, cream, butter, cheese, ghee, khoya, ice cream, kulfi and other dairy products. Forecast to grow at 11% per year from 2012–17, the industry is expected to see growth in the consumption of packaged milk over loose milk for food safety and convenience. This sector is dominated by cooperatives such as Amul, Vijaya, and Verka. While AP ranks #1 for milk and milk products, the segment is classified as polluting or ‘Red’ under Government norms and may not be set up within city limits.

Beverages: Accounting for INR 55,000 crore in 2012, about 8% of the industry, the beverages sector includes distilled alcoholic beverages, wine, beer, soft drinks, mineral water and other non-alcoholic beverages. Non-alcoholic beverages are expected to grow at more than 16% annually, and alcoholic beverages by more than 8% annually, from 2012–17.

The sector is driven by changing consumer preferences towards juices and soft drinks and the increasing availability of international alcohol brands. Key players include PepsiCo, Nestle, HUL, Tata, and United breweries. With high mango and lemon production in the capital region (AP is #1 for mango and lemon, Krishna is #1 for mango, and Guntur is #2 for lemon), Amaravati has high potential for fruit-based beverages.

Meat and marine products: With revenues of about INR 25,000 crore in 2012, or 3% of the industry, meat and marine products are expected to grow at about 17% annually from 2012–17 driven by changing dietary habits and increasing exports. This segment includes slaughtered, processed, preserved, sundried and
canned mutton, beef, pork, poultry and fish. Meat processing would not be permitted in the city, given the Government classifies it as ‘Red’. While AP is the top producer for marine products and accounts for about 60% of national shrimp production, these units are clustered in coastal regions and therefore not focus segments for Amaravati.

Fruits and vegetables: With revenues of about INR 10,000 crore in 2012 or about 1.5% of the food processing industry growing at 4% annually, this sector includes fresh fruits and vegetables, dry fruits such as raisins and cashews, processed and preserved fruits and vegetables (jams, jellies, pickles, sauces, pastes, juices, concentrates, potato flour, canned fruit and vegetables). This highly unorganised segment uses less than 10% of all produce coming from organised players and only about 2% of processing (vs. 65% in the US). Amaravati may focus on high-value fruit and vegetable products (AP is #1 for tomatoes, Guntur #5 and Krishna #7 in production) and opportunistic capture of other localised processing demands (Guntur is #3 for sapota, for example, and Krishna is #4 for cabbage).

II.iii. Value Chain

The agricultural value chain has six basic links:

Pre-harvest activities include purchasing seeds, pesticides, equipment and other inputs. Major organised players include Monsanto, National Seeds Corporation, Cargill, and Advantage.

Production involves all activities completed by farmers from ploughing and sowing to maintaining crops and harvesting; for dairy this involves livestock rearing and collection. Major organise displayers include co-operatives such as Amul and ITC.

Procurement and storage include obtaining raw material from producers and forwarding to processors by leveraging marketplaces, cold-storage chains, warehouses, etc. Major organised players include Food Corporation of India, NCMSL, and Arshiya International.

Processing includes converting raw materials to finished food products, grading, sorting, and milling grand packing. Major organised players include food-processing giants and FMCGs such as Cargill, Bunge, ITC and Dabur.

Retailing includes sales of ingredients and finished goods through shops, markets, malls, and cash-and-carry outlets. Major organised players include retail chains such as Spencers, Reliance, Godrej and Future Group.

Other services include corporate activities such as managerial, research and sales functions in headquarters, R&D centres and regional hubs.

Pre-harvest manufacturing, such as of pesticides and fertilisers, is low value-adding and often effluent-generating. It is typically located outside city limits with only sales offices in the city. Production and procurement and
storage are localised activities in and around farmland. Similarly, retailing is localised around customer hubs. Since anchor sectors are those for which Amaravati is renowned at a national or regional level, these sectors may not be developed as focus anchors, although they may be developed as required.

Amaravati should focus on food processing as an anchor segment due to the city’s natural advantage given its location in a rich agro-belt. It can also attract value-added services by providing excellent commercial and social infrastructure for companies to set up offices close to farmers.

In terms of services to support food processing, the region is highly attractive – typical HQ office space includes 150–200 employees per acre, for example – and absolute employment per unit is small; a typical Dabur regional office employs 30–40 people.

II.iv. Value chain – Food processing deep-dive

Food processing may be further sub-divided into three categories:

Primary: Basic processing of food produce includes washing, cutting, cleaning, and threshing. Proximity to raw materials is critical for perishability and logistics reasons, and value-add per product is typically low. The output typically requires secondary and tertiary processing prior to consumption. This may be a focus segment in Amaravati for produce from Krishna and Guntur.

Secondary: This includes processing primary produce to create ingredients such as pulp, flour, oil cakes, and slices. Proximity to raw material and primary processors is strongly preferred. Output such as flour may be packaged and sold or sent to tertiary processors. This may be a focus segment in Amaravati for produce from Krishna and Guntur.

Tertiary: This final stage of processing creates ready-to-consumer products such as ketchups, confectionaries, and packaged beverages. While proximity to raw materials is preferred, it is not always critical, as secondary processing often increases shelf life. This is the highest value-adding stage for most food products, given that it is typically done by FMCG brand owners which demand a premium. Given the low dependence on location and higher dependence on other benefits such as fiscal incentives and excise breaks, Amaravati may focus on this sector opportunistically with increased emphasis on companies in focus segments (e.g., Parle Agro for Frooti production).

In summary, from product-type segmentation, Amaravati can focus on grains and oil seeds, packaged foods, beverages, fruits and vegetables. From value-chain segmentation, Amaravati can focus on primary and secondary processing.

III.v Key trends driving growth in this sector

Demand fundamentals coupled with policy reforms driving growth of about 15% by
Demand trends within India and internationally, along with supply-based reforms, are driving growth in the food processing sector.

**IV. Policiesupport**

The Government has released multiple schemes which provide financial incentives, encourage foreign direct investment (FDI) and promote infrastructure: 100% FDI is permitted automatically for most food products, except for items reserved for micro and small enterprises. Mega food park schemes announced in 2008 provide one-time capital grants of 50% of project costs (excluding land) to a maximum of INR 50 crore. The Government offers tax incentives and other sops such as excise duty exemptions for equipment used in cold storage facilities. Regulators are transitioning towards implementing international quality standards, especially for exports and in sub-sectors such as meat and marine products, grains, and oilseeds.

**IV.i. Improved access to credit**

This sector has been given priority status for credit to promote entrepreneurship and investment, including:

- A special fund of INR 2,000 crore has been included in 2015–16 NABARD budget to provide affordable credit to agro-processing units.
- Reserve Bank of India has classified loans to food and agro-based processing units and cold chain under agricultural activities for Priority Sector Lending subject to aggregate sanctioned limits of INR 100 crore per borrower.

**IV.ii. Robust domestic demand**

Consumption is growing in India as the number of consumers grows and their preferences change. The country has the world’s largest youth population, for example, with about 572 million people under the age of 24, and they are more willing to try new processed foods. Food is more affordable, and household incomes are rising. As more women enter the workforce, families have more money but less time for shopping and cooking, creating a growing market for processed and premium foods. Meanwhile, people’s increasing awareness of health and nutrition are fuelling demand for premium products such as organic foods.

**IV.iii. Bourgeoning export opportunities**

- From 2011–15, exports increased at about 23% per year to roughly INR 145,000 crore to key buyers in regions such as the Middle East, the Americas and
Southeast Asia. This growth has been aided by improving standardisation and quality in food processing and packaging. Favourable supply-side dynamics include competitive production costs compared to other Asian and developing countries, India’s strategic geographic location, and its abundant raw materials.

Growth in global demand is likely to continue, fuelled in part by rising incomes and populations in developing economies. The Government can support this growth with incentives to the private sector. For example, it has exempted export earnings from corporate taxes and set up 60 Agricultural Export Zones across the country.

**IV.iv. Increasing organisation and changing industry structure**

The food processing sector is becoming more organised with the movement towards consolidated and integrated farming, which improves productivity per acre with more sophisticated and automated systems and machinery.

Organised retail accounts for only about 7% of the entire Indian retail sector, but this is increasing with the liberalisation of FDI and the emergence of players such as Bharti- Walmart, Future Retail, and Aditya Birla Retail.

**IV.v. Top needs in food processing and how Amaravati can meet them**

Food processing players across segments and the value chain expect an IRR of 10–15% on average, with brand owners extracting a more than 25%. To operate effectively and meet these IRR requirements, players select locations based on their needs along six dimensions:

**IV.vi. Proximity to raw materials**

The availability of produce is critical in terms of perishability and logistics costs. Agricultural zones or parks often fail to offer availability of the required agricultural produce, both in terms of quantity and quality, within a 100 km radius of the facility.

With a location in the heart of South India’s agricultural belt, Amaravati offers significant advantages to food processors. Krishna and Guntur are the top districts in India for valuable produce including dry chillies, maize, and mango.

Fiscal incentives: In addition to GoI incentives, state incentives and SEZ status have the highest impact on overall costs and are therefore the most important factors for food processing majors. While AP offers a competitive policy, it faces competition from other emerging states with aggressive fiscal policies. Madhya Pradesh, for example, provides customised fiscal incentives for project investments. This is facilitated by the state’s single-window investment clearance body Trade and Investment Facilitation Corporation Limited and...
approved through a fast-track APEX Level Committee headed by the Chief Minister. How incentives are granted is an important consideration. For example, most business leaders prefer upfront discounts rather than reimbursements as the latter can be time- consuming and require managerial bandwidth.

Andhra Pradesh is competitive in terms of fiscal incentives offered to food processors. Key elements of the policy include additional subsidies of 50% of food park project cost(up to INR 20–50 crore), 75–100% reimbursement of net VAT/CST/SGST for 5–7 years and 100% reimbursement of stamp duty. Fiscal incentives will need to be comparable to those of regional competitors to establish food processing at Amaravati.

Operational costs: Labour and utilities each account for 40–50% of total costs. They vary a sedon factors such as cost of living and access to grid power. For example, power from diesel-fuelled generators costs more than twice as much as grid power.

The region has moderate to high labour costs, with a minimum wages from about INR 200–300 per day, versus states with minimum wages under INR 200 such as Goa, Assam, and J&K. Power costs are competitive, however, and supply is reliable compared to other states due to a power surplus. The capital city is committed to supplying 24x7 quality power with an allocation of 1,000 megawatts from the Vijayawada Thermal Power Plant.

Infrastructure quality: Well-developed infrastructure in the form of reliable utilities, well-connected hubs and shared services may reduce overall operational costs by minimising disruptions, ensuring access to markets and achieving economies of scale. Uninterrupted water and power supplies are critical, for example, a water-tanker and generator costs are typically double those of grid supply. Reliable roads, rails, airports and seaport capacity ensure that goods may reach downstream processors and markets. Shared infrastructure, such as cold storage facilities, warehouses and packaging hubs reduce upfront of players and provides all benefits.

World-class infrastructure will give Amaravathi advantages. It is planned to offer year-round water from the Krishna River, for example, and assured power supply given earmarked capacity from Vijayawada, which should reach 1,800 megawatt sin the medium term after a capacity expansion. The city will be well-connected to the nearby metros of Hyderabad, Bangalore and Chennai, with two major national highways (NH4 and NH9), an airport, the second-largest rail junction in Vijayawada, and these a port in Kakinada, about 300 km away.

Cost of land: To generate IRRs of over 10%, processors must be able to obtain land at costs that are competitive with adjoining areas with similar agricultural productivity. Sri City had started leasing at INR 17 lakh per acre for a
99 year lease in 2010. Currently, the lease amount has risen from INR 35 to 50 lakh.

Ease of business and favourable labour laws: Quick ‘single-window’ approvals along with pre-approved plots with environmental clearance allow companies to operationalize and recover apex in 9 to 12 months. Sri City, for example, works with tenants one-on-one to help get clearances from various agencies. neighbouring state Telangana has released the Telangana State Industrial Project Approval and Self-Certification System (TS-iPASS) which provides permissions and licenses within 15 days, with approvals deemed to have been given beyond this period.

Favourable labour laws include terms for contract labour and unions – key considerations as this sector employs over 80% contract labour due to seasonal operations.

Andhra Pradesh is considered a business-friendly state and was the first to implement single-window clearances. The World Bank ranks it second in the country for ease of doing business. Amaravati is committed to providing best-in-class ease of business required by food processing investors including ready-to-occupy plots with environmental clearances, and single-window support within predefined timelines.

**IV.vii. How Amaravati can avoid the pit falls that caused most food parks to fail across India**

If executed well, food-processing parks can have a sizeable impact on job-creation and agricultural productivity. These parks provide considerable scale economies, allowing tenants to increase productivity by more than 400%. Despite these factors, only five mega food parks have succeeded of the 42 sanctioned as per the national Government’s scheme. Four main issues have hindered their progress:

- **Land acquisition challenges and delays in statutory approvals from the state government:** Food parks required more than 50 acres, but given small parcel sizes across multiple farmers, food processors incurred high transaction costs and legal delays in acquiring land. State-specific strict land ceiling and sub-leasing laws limited how much would be acquired and prevented subleasing in certain states. For example, Kolkata-based Keventer Group got approval in November 2011 for a 50 acre food park in Bhagalpur, Bihar. Despite paying the government in full for the land, it could not get possession due to protests and lack of state and government support. Approval was cancelled in June 2014.

- **Speculative buyers with no intention to operationalize:** The scheme attracted developers who were interested in obtaining low-cost land with the INR 50 crore grant, getting permission to change the land use from agricultural to industrial and waiting for prices to appreciate. These developers did not intend to build businesses in the parks, resulting in more than 17 license cancellations by the government.
Availability of raw materials in catchment area: Many food parks and clusters were set up without considering the availability of critical raw materials in the vicinity. Some also lacked infrastructure, which further confined the catchment area and limited growth.

Costs for tenants and food park developers: Rents are often two to five times higher in food parks than in adjoining areas due to infrastructure facilities offered. While productivity benefits may far outweigh rental costs, small food processors have been reluctant to move to parks. Additionally, banks were not familiar with the food park business model and routinely charged higher interest rates for financing in parks than for individual units. Srini Food Park, for example, secured financing at 12–16%, whereas most food processing units can borrow at 9%.

Much can be learned from the pitfalls faced by delayed food processing projects across India, as well as from success stories such as Srini Food Park, Patanjali and Sri City. While Amaravati has the advantage of proximity to raw materials, it could also provide developers with encumbrance-free land as part of the master plan, establish strict evaluation criteria for selecting food processing and industrial park developers, develop excellent connectivity infrastructure to source raw materials as link to export markets, and offer a compelling economic proposition in terms of capital and operating expense savings.

V. Implementation plan for Amaravati

In the short and medium term, Amaravati aims to promote ecological farming practices while offering high-quality infrastructure at competitive rates.

To build a vibrant hub for food processing, the following implementation ideas and requirements may be considered:

Establish organic farming practices: As the wellness capital of India, Amaravati will promote ecological practices such as organic farming, which relies on natural fertilisers, pesticides and seeds, avoiding or excluding synthetic inputs. For example, relying on crop rotations, manure and bio fertiliser store perish soil nutrients and introducing insect predators or natural pesticides such as rotenone or pyrethin to prevent pests. Effective organic farming offers healthy produce which may contribute to well-being of local consumers and can be exported at a premium—all while main training productive outputs.

Create a food processing hub with shared infrastructure within the industrial park: The city could establish ready-to-occupy plots for small, medium-sized and large business across primary, secondary and tertiary food processing. The park could provide top-class shared infrastructure including central
processing centres, 24x7 utilities, warehousing and cold-storage facilities, transport solutions and linkages, R&D labs and effluent treatment plants. This would benefit food processors by reducing upfront capex and ensuring reliable operations with minimal disruptions, in addition to facilitating efficiency through economies of scale with shared facilities such as storage and packaging.

Leverage regional advantages of top crops in Krishna and Guntur: The city could focus on the top crops produced in Krishna and Guntur including sugarcane, rice, tomato, maize, and mango. It could focus opportunistically on other surplus crops in region including banana, lemon, brinjal, pulses, groundnut, coconut, and cabbage.

Develop sector infrastructure including cold chains and warehousing: One of the biggest challenges faced by the food processing industry in India is the lack of quality infrastructure including road-rail access, cold chain facilities, warehousing capacity and packaging facilities. This need for reliable infrastructure and logistics is an emerging investment opportunity for local entrepreneurs and national players to set up in Amaravati for food parks, cold chain logistics and third-party logistics. Amaravati aims to promote public/private partnerships to attract further investments.

Promote Amaravati as a hub for modern trade sourcing: Only about 7% of India’s retail sector is organised, but this proportion is growing rapidly with relaxation of FDI limits in modern trade. Amaravati can attract emerging retailers not only to set up operations but also to source products. Given the new population base expected to emerge in the new capital city and its proximity to adjoining metros Hyderabad, Chennai and Bangalore, it can develop as a sourcing hub for organised retail in the south. This could be facilitated by setting up terminal markets for fruits and vegetables and facilities for sorting, grading, packing and cooling. The city can also explore launching online marketplaces and exchanges for food and food products to improve efficiency in the supply chain and drive value for producers.

Improving productivity of local farmers: Although India is a global agricultural powerhouse; outputs are 10 to 50% lower than Asian averages. For example, in case of rice production, India averages at 2.3 tonnes per hectare versus China have a output rate of 4.7 tonnes per hectare. A large body of academic research has highlighted the vital role of agricultural productivity and food processing in reducing poverty in developing countries. Amaravati will adopt a variety of measures to improve farmers’ productivity including improved access to credit, training programmes and research and implementation of precision farming – the latest practice of tailoring the use of seeds, fertiliser, equipment, and processes to highly site-specific conditions.
Focus on value-added and progressive farming services: Amaravati can offer an ideal incubation hub for cutting-edge research and applications of progressive farming techniques. It may promote greenhouses, for example, to provide high-quality controlled output critical for food processing majors. Amaravati can promote research and on-field dissemination of best-in-class pre- and post-harvest production methods including hybrid seeds, organic farming and investment in irrigation. Amaravati can also opportunistically target food processing companies to set up national headquarters, regional offices and R&D centres in the city. While these services jobs are highly attractive, with nearly 200 per acre, the overall scale of employment is low. These measures will pave the way toward Amaravati’s long-term goal of becoming a capital for agriculture and food processing and a mecca for cutting-edge developments in this sector, not only for India but also internationally.

V.i. In the long-term, Amaravati can become Asia’s hub for organic food and new-age agro practices

Raising the productivity and performance of these sectors, including food processing, is the most direct route to addressing poverty as it increases the income of farmers and provides employment opportunities in agro-based enterprises. There is much room for improvement, as agriculture has not kept pace with recent growth in India’s broader economy. Amaravati’s long-term vision is to emerge as Asia’s biggest hub for organic produce, a fast-growing segment globally due to increasing health-awareness. ‘Made in Amaravati’ is envisioned as a brand which would be renowned for unadulterated natural food products been grown and processed using organic practices. In the long run, the city plans to help farmers transition to 100% organic farming practices without any synthetic fertilisers or pesticides or genetically modified seeds. It aims to provide much-needed support to the livelihood of farmers through maintaining strong output with higher-value produce which may be exported at a premium.

In addition to organic agro and food processing, productivity is an area where Amaravati aims to make significant advances. Crop outputs in India remain well below potential due to a number of structural factors: low investment in agricultural infrastructure, research, and extension services; an inefficient land ownership model; and market distortions that discourage productivity-enhancing investment.

Bringing India’s outputs in line with those of other emerging Asian countries could reduce the population below the Empowerment Line by 10% points, raising more than 125 million people above the line. In addition, the ripple effects of agricultural growth are felt beyond the farm sector. As farmers
earn more, they demand more consumer and durable goods, bolstering India’s expanding manufacturing and service sectors.

With this context in mind, Amaravati plans to build an ecosystem that attracts top talent and drives cutting-edge research and implementation. The aim is to rethink and transform the entire value chain from pre-harvesting to processing and packaging with the dual goals of higher productivity and healthy produce.

V.ii. Promising research areas which Amaravati could explore include:

Vertical farming: Farming can occur indoors in vertically stacked structures or buildings with artificial light, temperature controls and water supplies. This practice allows the highest quality control and provides opportunities for new product classes within foods. In Japan, for example, vertical farming has been applied in Fukushima for consumers concerned about radioactivity. Only a handful of other commercial vertical farms are operating so far, such as the world's first commercial vertical farm in Singapore. Developed by Sky Greens Farms in 2012, it is three stories high.

Festation and chemigation: Fertilisers, pesticides, herbicides, and irrigation can be applied more scientifically to control dosage and improve absorption.

Hydroponics, aeroponics and aquaponics: Plants can be grown without soil, in water or using airborne moisture, and aquaponics combines hydroponics with symbiotic aquaculture of fish or prawns.

Precision farming for small farm owners: Precision farming, which provides specific feedback about inputs and practices through monitoring of local conditions, has been applied in its true sense only on large commercial farms. Innovations that would allow small farms to apply these practices in a cost-effective manner would be game-changing.

Industry 4.0 for the farm: The internet of things – an interconnected web of sensors, computers and equipment – is improving decision-making and automating tasks in many industries, including agriculture. Equipment major John Deere has made inroads into this technology and offers GPS-controlled self-driving tractors, for example.
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