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Micro Agriculture Logistics System for the rural farmers of the state of Tamilnadu, India

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Abstract*– COVID-19 has had a disproportionate impact on the people of Tamil Nadu - a state on the southeast coast of India. Forty percent of the population farms land that is 5 acres in size on average. The pool of available truck drivers to deliver produce from farms to markets has shrunk substantially due to restrictions and fears of COVID transmission. Many regional markets have also closed due to COVID fears. As a result, farmers are forced to sell their produce locally at substantially lower prices, that are unsustainable in providing basic income. Even prior to COVID, the small size of Indian farms are not conducive for economies of scale, equipment/technology investments or supply chain efficiencies. Farmers also have limited ability to engage technology due to a lack of education and resources. Improvements to the agriculture supply chain in India are critical, both during COVID and in order to build a more sustainable future for farmers. This paper proposes a Micro Agriculture Logistics System which leverages existing technologies to facilitate transportation and distribution through a community-based infrastructure. The solution will increase efficiencies in connecting drivers with farmers, identify alternative transportation modes, decrease spoilage, and digitally deliver payments throughout the value chain.

***Keywords--* Disproportionate impact, Agricultural supply chain, Micro-agricultural logistics system, Technologies.**

I. Introduction

The United Nations 2030 Agenda for Sustainable Development focuses on, "no poverty" and so across the globe it becomes vital for any country's growth. Agriculture has marked its presence at the global level through enormous supplies of exports to countries across the world.

Agriculture has been a backbone of the Indian economy ever since independence. In fact, even before the declaration of independence, India was one of the few agriculture dominated economies in the world. Agriculture's contribution of around 16% in India's GDP is much higher than the world's average of around 6.5%. At around $375.61 billion contribution in the year 2017, India was the 2nd largest agricultural producer in the world. However, the share of agriculture and allied services has been on a constant decline ever since 1951, during which its share was close to 52% in the total Indian GDP. The Indian food and grocery market is the world's sixth largest.

Until now the agricultural market was strictly organized, and small-scale farmers basically were tight to intermediary traders, aiming for low purchase prices but intensive margins. In India small scale farmers bring their produce to state-designated mandis. That means that farmers were not allowed to sell their produce freely to wholesalers, other buyers or e-trading platforms. Farmers are dependent commission agents called arthiyas which basically dictated the price when buying the produce of the farmers before selling it to new customers [1]-[2]. Presently, on average there is a 120% increase between the prices Indian farmers typically receive for their produce and the price at which it is sold to the retailer [3]. According to NCCD, the price wedge between farm gate sales and terminal wholesale can be as high as 1000% for perishable produce. Since COVID-19 forced the gross of the markets to shut down, including the biggest one in the state of Tamil Nadu [4] farmers not only face a lack of income but face even more capriciousness from the local vendors. Farmers are afraid to bring their produce to the few left open local markets. As a result, local vendors take advantage of this and negotiate even lower prices for the produce [5]-[6]. Prices have dropped severely, and some crops are just worth 1/10 as in pre-COVID-19 times [7].

An additional challenge in the agricultural supply chain are the severe losses in crop, not only COVID-19 times, but in general. For some crops, up to 40% of the harvested produce is lost between the farm gate and the market. These losses are a result of bad farming, storage, transportation, and procurement practices employed by the supply chain players. This reduces the farmer's income, his capacity to invest and fails to provide him with an incentive to grow more produce. Also, in a rapidly urbanizing marketplace, such huge loss of produce negatively impacts the cost of food and subsequently affects the end consumer.

TABLE I
Loss of crops

	Lower limit	Upper limit
Cereals	3.90%	6.00%
Pulses	4.30%	6.10%
Oil-seeds	2.80%	10.10%
Fruits	5.80%	18.10%
Vegetables	6.90%	13%

Even after so much production of agricultural crops in the country and export of the produce to other countries, data shows that there is substantial loss of the produce in the supply chain. Table 1 illustrates the loss of crops in terms of

percentage for various types of agricultural produce in India (source).

Cereals, such as rice, wheat, and maize undergo a minimum of 3.9% loss with the losses going up to 6%. Similarly, in the case of vegetables, the losses go up to a whopping 18.10%.

Figure 1 displays details in the post- harvest losses for tomato, potato and onion crops in the various stages of the supply chain. It can be concluded that losses vary in terms of handling and sort of crop.

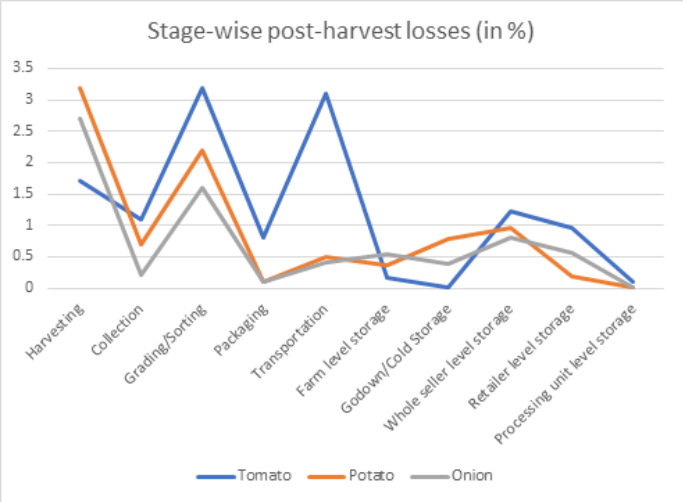

Fig. 1 Post-harvest losses.

It can be seen that maximum losses take place in harvesting, grading/sorting, transportation, and wholesaler level storage. These could be some of the pain points to be addressed using some technological solutions.

Due to the COVID-19 pandemic the borders between the Indian states but also within states are closed. This has a severe impact on the agricultural trade since products cannot be transported across borders anymore. According to [1] today "only about 20% of India's roughly 9.8 million trucks are currently operating (..)", writes that on day 2 and 3 of the lockdown 90-95% of the transport came to a standstill.

An additional factor is that truck drivers are afraid to drive in times of COVID-19 [1]. Truck drivers are afraid of driving down to villages to pick up vegetables. To get the produce to the customers, the farmers are forced to pay a higher price. As the lockdown hit India, thousands of truck drivers stranded at the borders and are relying on help for survival. Also trucking companies report losses up until 5.000 rupees per day per vehicle [2]. Truck drivers are demanding more and the cost of production is more than the selling price [3]. In India in November and December 2018, Lasalgaon's farmers were forced to sell their onions for as little as Rs 2 per kg – and some farmers claim they got even less. Frustrated by the government inaction, two farmers from Nashik dumped 30 quintals of onion on the roads at the time (1 USD = 75 Rs) Aarefa [4]. In the month of August 2020, the farmers are again up in arms as the prices plummet and there is more supply and less demand. That in combination with the scarcity of truck drivers and increased transportation prices makes it impossible to sell products for a margin worth living. This results in a high spoilage of produce as indicated earlier.

One of the farmers in Tamil Nadu, who was interviewed by one of the team members of the project pointed out that the average area the farmers hold is 2 to 3 acres in his village. They grow paddy, sugarcane, groundnut and vegetables. Before the onset of the pandemic, they faced problems with middlemen and lack of enough transport facilities. Because of lack of storage facilities they were forced to sell their produce for a lesser price. After the onset of pandemic, the price has come down very much as the consumption has reduced. Very high humidity, frequent rains, lack of storage facility, lack of technology are making the situation all the more tough during pandemic. Therefore, it needed to be looked at supply chain workings within crisis and disasters but also at an approach how to improve the agricultural supply chain for small scale farmers in India, taking the latest changes in federal policies in terms of market liberalization into consideration. Table 2 shows an overview of some characteristics of the state of Tamil Nadu. The data were provided by the MINISTRY OF AGRICULTURE & FARMERS WELFARE GOVERNMENT OF INDIA.

TABLE II
CHARACTERISTICS OF TAMIL NADU

Heading level	Tamil Nadu, India
Population	82.43 million
Square miles	50,216
Population density	1,681 people per sq mile
Farm labor	32.88 million
Farm labor as % of population	39.88%
Crops	Rice, jowar, ragi, bajra, maize, pulses, cotton, sugarcane, tea, coffee, and coconut.
Climate	Hottest month-May (33 °C avg on avg) Coldest month-January (25 °C on avg) Annual rainfall-194.61mm (per year) (Time and Date, 2020)
Educational attainment	8th to 10th grade (middle or high school level)
Average Annual Household Income	Rs 214, 236 (USD 2875)
Agriculture output	275 million tones
Agriculture output as % of total GDP	13%

The COVID-19 crisis had and still has a strong impact on the Indian small-scale farmers. The crisis pointed out the deficiencies in the agricultural supply chain of poor farmers even more. Already before the COVID-19 crisis it was apparent that Indian small-scale farmers were not conductive for economics of scale, investments and that they faced supply chain inefficiencies. The current pandemic has increased the

necessity to find models for a more advanced food supply chain between the farmers and their customers.

II. Literature Review

As the COVID – 19 pandemics is progressing still in many parts of the world, trade-offs have emerged between the need to address and contain the virus and to avoid crises that slows down the economy and create food scarcity. The poor are the most affected. Although no major food shortages have emerged as on date, agriculture and food markets are facing an unprecedented disruption, mainly due to labor shortages created due to restrictions. This is affecting logistics and cutting across into the regular supply chain. Availability of properly sanitized produce, accessibility to market, utilization of available produce and infrastructure and stability in market are the major factors that are hit during this pandemic. Study on micro agricultural logistics has addressed most of the issues by elaborating on the issues and going into the root causes of the problems.

Population-level COVID-19 containment strategies have been particularly hard on the urban poor and vulnerable population groups such as female headed households, children, youth, the homeless, informal sec-tor employers and employees, casual workers, the unemployed, and migrants and refugees. As a direct result of the COVID-19 outbreak, a secondary pandemic of hunger and food insecurity is now impacting many of these groups.

As the bigger markets are closed and the supply chain is severely affected the farmers are forced to find some place along the roadside (See Fig. 2) or in the deserted bus stations (buses are off the road) to sell their produce.

Fig. 2. Farmer selling produce.

Farmers are forced to use any vehicle that is available (figure 3) to transport their produce to the places of selling. Constant exposure of the produce to sunlight reduces the shelf life of the produce and many farmers are seen dumping their unsold produce at the end of the day.

A lack of transport, shortage of labour, and lack of cold storage facilities has forced the farmers to dump their produce [1]. More than two thirds of the household depend on farming and 93% are small farmers. According to a survey conducted in the year 2016 – 17 by All India Rural Financial Inclusion Survey income of a household is Rs 9975 per month. Even though the expected production of food grains in Tamil Nadu in the year 2019 - 2020 was estimated to be 11.5 million tons, due to the pandemic the farmers are very badly hit and are in great distress.

Fig. 3. Truck for transportation.

For the literature review it was therefore looked at current research about the impact of the COVID-19, but it was also investigated which learnings were revealed from research on supply chain management with regards to disaster management and humanitarian logistics.

As [2] have pointed out, disasters have multiplied six fold in the past 30 years. It is expected that disaster impacts through climate change, environmental degradation, and rapid urbanization will multiply by 5 during the next 50 years [3]. Disasters will continue to happen in the future. Therefore, mature thus collaborative and responsive supply chains need to be designed [4].

Plenty of research has been executed in the field of humanitarian logistics. Where the prior purpose of this paper

is to recommend a sustainable and long-term system to enhance the efficiency of small-scale farmers supply chains, it became apparent that disaster relief and mature humanitarian logistics becomes especially difficult, yet important, in countries with an unstable and complex political system and environment, poor infrastructure, challenging customs clearance and theft [5]. A logistics manager being used to advanced logistics, infrastructure and systems must be able to blend first- and third world logistics being aware that profit cannot be the primary motivator in disaster relief [6].

When talking about resilient supply chain management for the future in order to increase small scale farmers' life quality it is of importance to also take ecological sustainability into consideration and to not only focus on financial sustainability. As customers develop a higher sense of ethical products, sustainable supply chain management, even if it's in an immature stage, has to take ecological sustainability into consideration to protect the resources. This addresses the production of food, the packaging and also the transportation mode [7].

The effectiveness of humanitarian aid depends on logistics information and knowledge management [8]-[9]. Often resource and process constraints are a limiting factor in humanitarian logistics [10].

[11] points out that humanitarian logistics relies on processes and systems involved to help affected people through mobilizing resources as skills and knowledge and manpower. According to [12] there're five key factors of preparedness for disaster relief: human resources, knowledge management, operations and process management, financial resources, and community.

The planning and execution of the key factors is, according to [3], too often done ad hoc in many cases. Often a coordinated approach with horizontal and vertical collaboration is lacking [13]-[5]. A lack of coordination, the absence of clear responsibility and the difficulty in funding operations often lead to a deficit in response time [2]. Planning and preparedness is often lacked and as a result disaster relief has to be organized after the event has already happened.

[4] have developed a response model for a tsunami hit in Thailand, this model proposes a 72- hour time frame in case a tsunami should hit. Even though COVID-19 is of different character, the basis of the invented model is still applied to effective disaster management and efficient, futureproof supply chain management. The model clearly indicates the jurisdiction and job description of each agency involved in the relief operations. It is shown that horizontal and vertical linkages between departments represent the vital parts of successful overall emergency response. [14] recommends a well- established decision support system when it comes to a mitigation strategy. A mitigation strategy demands organization and pre-planning but also flexibility.

It therefore needs to be identified which resources to be used so that the inflation of help is prevented but instead the right resources are used in time [15]. The information provision plays a crucial role in enhancing supply chain resilience. Not only can information be used to coordinate a stable network in general, but information also nowadays plays an essential role in knowledge enhancement and education. [16] points out that the usage of the internet can alleviate the impacts of a crisis if information is processed and translated appropriately into valuable learnings.

The involvement of governmental and non-governmental actors plays a crucial role [17]-[2]-[18]-[6]. It is of importance that the responsibility is spread across several players in order to keep the risk on power inequality and dependence low [19]. This enhances the ability to respond effectively in crisis and in order to build a resilient supply chain.

Networks, collaboration, the involvement of the community and capacity building are seen as enablers for responding to disasters. The solutions to this paper will take those major factors into consideration. The involvement of the community and facilitating bonding of social capital within the community is seen as important for risk mitigation and response to crisis [20].

The prior question of this paper to be answered is how to organize and facilitate supply chains which will not only ensure income during the COVID-19 pandemic but will be enabler for the better living of the farmers. As mentioned previously, therefore it is not only to be looking at disaster management but also at general supply chain principles. It became apparent that many recommendations and findings refer to logistics and supply chain principles. Strategic planning, inventory management, transport and capacity planning and information management and technology utilization, human resources, continuous improvement are the outstanding success factors in supply chain management, independent of a crisis [21].

The prior goal of this paper is to show long-term solutions for a more mature supply chain which enhances the income of small-scale farmers in India. Planning and coordination are seen as enablers to mitigate risks and for being responsive in crisis but also to increase efficiency. [19] in their study developed a model which determines the numbers of distribution centers needed in a relief network and also, they took the stock needed for relief into consideration. They concluded that the response time for providing aid can be decreased and therefore the service level towards the people in need increased. For the current study about the maturity of the Indian small scale farmers supply chain the role of small-scale distribution centers attached to the community will play a key role.

Research has pointed out that building disaster relief supply chains demand planning, collaboration, coordination and execution on a strategic, tactical and operational level. It is now enough to react ad hoc after the disaster has occurred. Special attention is given to the need for a solid information system which provides visible data to the supply chain players involved. Information systems should be used as well for analysis. Also, information systems can support the learning and knowledge transfer (Oloruntoba, 2015). It also became apparent that logistics faces challenges dependent on factors

such as available (IT) infrastructure, the political/ environmental stability or the availability of resources such as finance, people and knowledge.

In order to develop a more mature supply chain for small scale Indian famers it therefore needs to be assessed carefully which resources and conditions are given in the state of Tamil Nadu. The developed model aims to provide a long-term solution not just for the state of Tamil Na-du but for farmers across India. Still the approach is to first implement the suggested solutions on a local base to test its stability and workability. As [4] pointed out it is about quality management in the supply chain. That demands a thorough evaluation of steps taken and if needed an adaptation of the model.

It can be concluded that small scale farmers face severe challenges, even stronger than in the past. The psychological safety due to the COVID-19 pandemic has decreased amongst farmers but also amongst truck drivers and other parties in the supply chain. Insecurity leads to more dependence, spoilage and exploitation. Beside the fear, especially in times of disasters, the immaturity of logistic systems becomes more apparent and severe. as literature review revealed, it is necessary to co-ordinate, delegate and collaborate, in the best case supported with proper information technology. As the laws in terms of the liberalization of the agricultural market has been recently changed, farmers cannot take more responsibility in terms of negotiating prices when approaching customers directly. Hence, this places the challenge that farmers need the knowledge and the access to this information. The researchers in this paper will propose a model for a mirror logistics system to enhance efficiency amongst the small-scale farmers supply chains.

III. Applied Research Methods

The primary focus of this research is to develop a model to increase Indian small scale farmers income through designing a more efficient supply chain for within and for post the COVID-19 pandemic.

The collaboration of the researchers from the US, India and the Kingdom of the Netherlands is based on strategic partnerships between the institutions.

For the model the aim was to share best practices of every country and to combine the knowhow of the researchers of the different countries in order to enhance the agricultural supply chain in India.

The overall research questions were twofold. On the one hand the impact of the COVID-19 pandemic on the agricultural supply chains should be investigated. On the other hand, the major purpose of this research is to give answers to the question “How can the supply chain of the Indian small-scale farmer be designed in order to ensure a better income within and post COVID-19”. The solution will increase efficiencies in connecting drivers with farmers, identify alternative transportation modes, decrease spoilage, and digitally deliver payments throughout the value chain.

Plenty of publications exist on the topic of the poor circumstances small scale farmers in India face. They earn an income which is hardly enough to survive. Therefore, this research not only aims for a solution for the COVID-19 pandemic but aims to develop a sustainable model.

For the research design a set of questions had been developed. This set formed the baseline for conducting the research. Every researcher investigated information. Due to the only recent occurrence of the COVID-19 pandemic not much information is given about the impact on agricultural supply chains. Therefore, the researchers rely on news articles when it comes to comparing the characteristics of the agricultural chain.

To be able to answer the research questions, the researcher’s secondary literature review and utilized published peer reviewed articles, newspaper articles, governmental reports and other published information from f.eg. industry associations.

Furthermore, primary information was gathered through discussions with local stakeholders, especially in the state of Tamil Nadu. Interviewees ranged from local fishermen to local community and industry representatives and university researchers. As the utilization of local resources is the essential part of our developed solutions, the discussions with the local representatives helped to validate the applicability of our findings and proposed ideas.

The developed solutions will be out rolled to the Indian country once they have been tested and approved in the state of Tamil Nadu. That means that the module still has to be proven in reality. The reason for the choice of Tamil Nadu is given to the circumstance that the major project partner is located there and, even of more weight, that Tamil Nadu’s population works with 40% in agriculture.

Still very little scientific evidence is written about the impact of COVID-19 on the agricultural supply chain. That is the reason why researchers utilize data from recognized newspapers and news sources. The interviews with the farmers have been conducted informally and were intended to gather firsthand information and to get a feeling about the current sufferings the farmers are facing.

IV. Results

This paper aims to propose a sustainable model for small scale farmers in India in order to build and maintain a more efficient supply chain during and post COVID-19.

As an essential part of disaster relief, the involvement of the local community beside public and private stakeholders is inevitable [1]. For being able to ensure working operations it is necessary to have a solid coordination and active planning. Both need to be structurally described, delegated and implemented. Additionally, the availability and usage of information systems helps to collaborate, it supports process efficiency, and it increases responsiveness.

When talking about supply chain management in (non) crisis situations, the choice of the means of transport can

leverage supply chain efficiency and effectiveness. With a suitable choice of transport modality, delivery times can be shortened, delivery options be increased, cost be reduced and the reach of customers expanded.

As a last factor to be considered ecology plays an increasing role in customer choices to buy a product. Customers in the NL and US tend to buy more local and also the Indian government invests into buy local campaigns. The global demand for preserving resources is essential to consider when developing new supply chain models. Additionally, customers consciously look for organic farming yet still demand fresh products which are continually available and affordable.

Our model proposes a Micro Agriculture Logistics System which leverages existing technologies to facilitate transportation and distribution through a community-based infrastructure, connecting supply and demand throughout the supply chain and investigating ways to decrease spoilage of produce, (see Fig. 4).

The involvement of the local community when it comes to coordinating goods flows and the planning of resources is crucial, as pointed out earlier. Therefore, the model proposes a Community Coordinated Pro-duce Sales & Distribution approach. Here the community center in the different districts within the province of Tamil Nadu are assigned responsibilities (yellow) regarding the management of the goods, information and money flow (appendix II). It will also serve as first contact point to customers and as a training hub for local farmer education programs.

Regarding the improvement of efficiency in terms of the logistics process, the community center basically serves as a physical hub for the coordination of the produce flows between farmer and end-customer. The end- customers can be private households or businesses as market sellers or retail shops.

The end customer (red) orders its products at the community center. This can be done by digital means (e-mail, WhatsApp), by a phone call or on location itself. The community center either immediately orders the produce at the farmers (green) or collects order until a minimum order size is reached and then it will be ordered at the farmers. One order from a customer can include orders for several farmers.

The community center decides whether an order is big enough to be shipped directly from the farmer to the customer or if it needs to be shipped to the community center first.

When it is shipped to the community center first, the orders would be commissioned to one delivery. The customer has the option to pick up his order himself at the community center. Therefore, the community center informs the customer when the order is ready to be picked up. In case the end-customer wants his order to be delivered, the community center books the respective driver.

The community center therefore not only takes care of the order management but also it is in charge of the transport planning and coordination. That also includes the choice of modality.

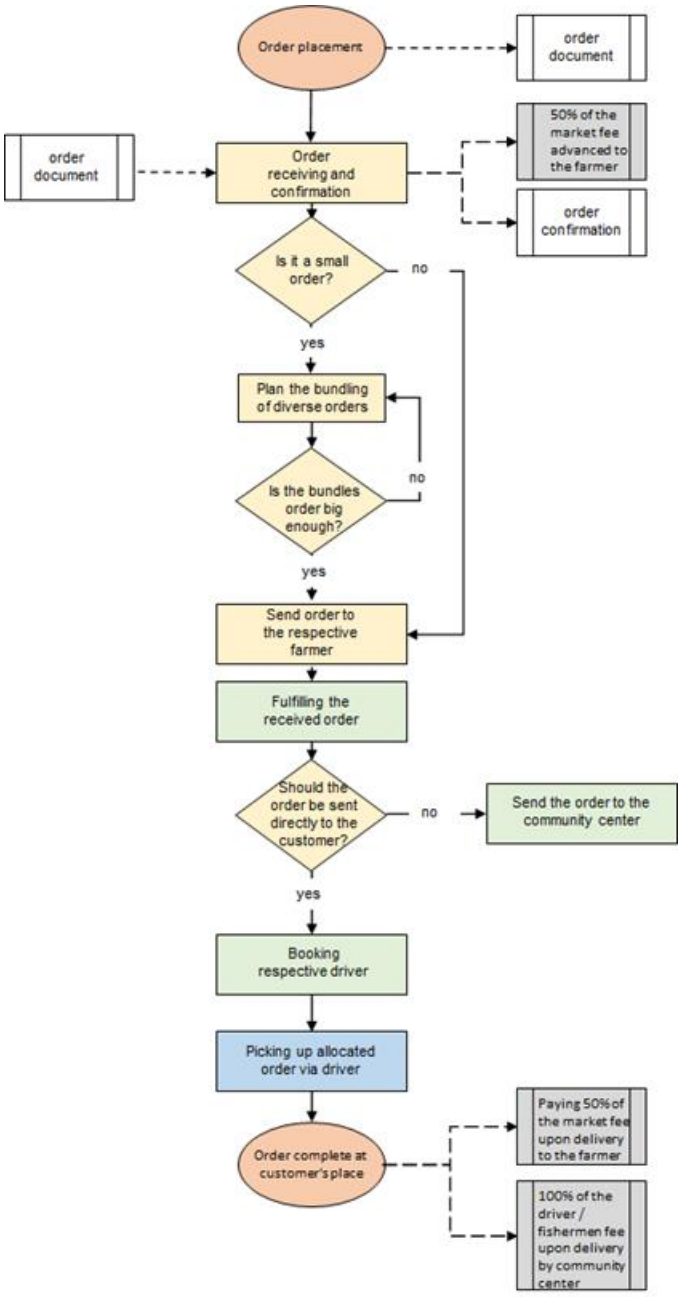

Fig. 4. Flow and the planning of resources.

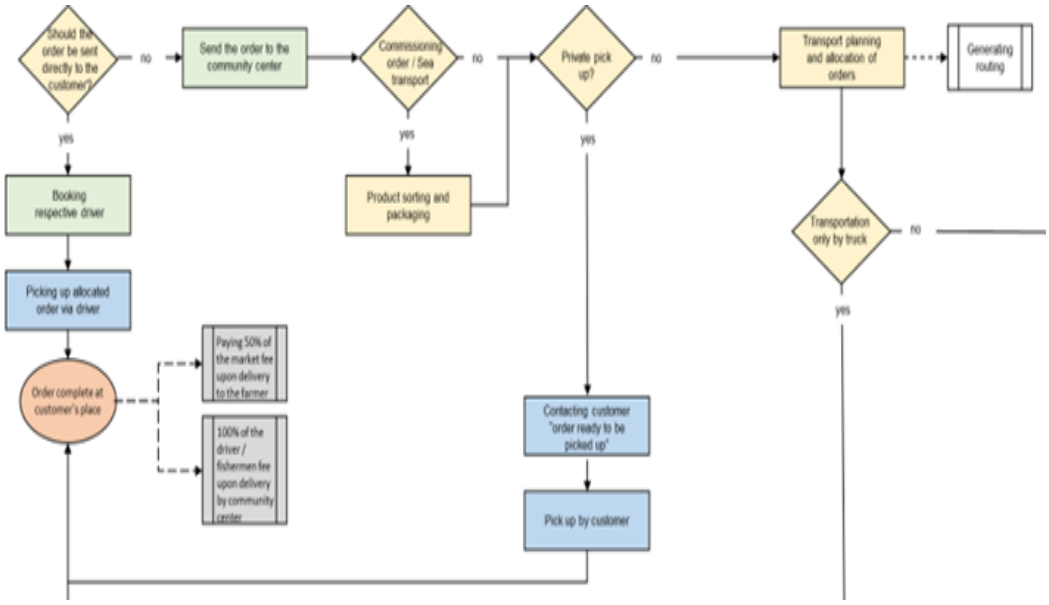

Fig. 5. Transport planning and payment.

For the delivery of the orders to the end customers, the community center can decide between road, water and rail. As there is a huge shortage of truck drivers due to the COVID-19 pandemic the community center can navigate the orders to the fishermen which will deliver the order. Taking the strict regulations by the Indian government into consideration, in times of the COVID-19 pandemic, it is not allowed to cross districts by the means of cars or trucks. Water and also rail is allowed. The use of rail still has its limitations. The train schedule is irregular and due to the absence of a fully capable application where pick up times and also payment terms can be handled, the rail option will not further be explored here. That's why in this model an increase of water transportation capacity is suggested.

By fiber boats (appendix III) fishermen can transport up to 500kg produce in a 25-30-km range (revealed from direct dialogue with fishermen). The delivery time would be 10 hours, depending on the distance. Appendices IV and V reveal all ports in Tamil Nadu and show the patch within a 25km reach. It is recommended to only utilize water transport if the community center or respectively the customer is not farer away than 25km from the port as well. This is due to the reason of transport time and the increase of costs to or from the port.

From the community center the produce would be transported to the ports to hand it over to the fishermen. Interviews revealed that fishermen need a prior notification for a delivery of 4-6 hours ahead.

When the fishermen arrive at the destination port, he calls the community center. The community center then would again book a respective driver to pick up the orders and deliver it to the end customers.

As this model aims to be sustainable and usable in the long term it was investigated which applications are currently used for payment (grey) and transport ordering. It turns out that Google Pay (Gpay) with over 67 million monthly active users is a common application to use for financial transactions. Therefore, it is recommended to promote and utilize Gpay for the transfer of money between the community center, the farmers and the customers. Customers pay directly to the community center before or after delivery. In order to sustain and manage the community center, it is recommended to keep 5% of the payment for this.

The community center pays the farmer. Here the research team suggests that the farmer is paid a 50% fee once he receives an order. That lowers the financial risk for the farmer in case the produce gets lost on the way.

The community center and the farmers will utilize the application Lynk for the booking of transport capacity. Lynk was founded in 2015 [1]. In 2019 it had about 800.000 active users and a capacity of 9.000 trucks and bikes [2].

Through Lynk it is possible to choose the means of transport. Those range from a truck to a Piaggio Ape, a bike or a scooter. Through Lynk it is possible to pay the driver directly. That enhances flexibility in terms of the transport capacity needed. It can be reacted flexibly to order size, delivery times, costs can be optimized and the supply chain efficiency enhanced since payment and transport planning can be done in one step.

The utilizati4on of information systems has, according to [3], the advantage is that collected data can be analyzed and used for process improvements, planning and predictions. Additionally, the transactions of transport and payments can be monitored in order to leverage the publicity of the system. This will be further elaborated in the next chapter.

[4] pointed out that consumers pay increasingly more attention to the ethical, sustainable and ecological aspects of products. A major problem for small-scale farmers is that they often need to scrap their produce due to low margins or, especially in the COVID-19 time, due to a lack of transport opportunities to their customers. Small scale farmers don't have the opportunity to store their produce. Therefore, storage capacities need to be installed in order to decrease food waste and in order to increase financial turnover for the farmers. The community center in time could serve as a distribution center. As a community center now is in charge of bundling and commissioning orders in the future it can offer affordable storage capacities. Through investments into the community center and through further research in affordable cooling options, storage of farmers' produce could be guaranteed up to a certain capacity.

In addition to storage facilities, it needs to be looked at ways to enhance the shelf-life of produce. Protecting nature and farming sustainably becomes more important on a global scale.

V. Discussion

Our model proposes a Micro Agriculture Logistics System which is operated by a community-based approach. The study has identified the community centers in the villages of Tamil Nadu. Community centers are run by the Government of Tamil Nadu at present. In the places where community centers are not run by the state governments, this study proposes panchayats to run the community centers, maintain and collaborate between the farmers, truck/mini truck/bike drivers and customers.

One of the initiatives of the Government of Tamil Nadu is an IT enabled center (community centre) accessible to the common man in his/her village. The purpose of these centers is to provide financial, social and private sector services in the areas of agriculture, education, or banking [1]. Micro Agriculture Logistics compiled a model to consider this community center to be a hub in providing uninterrupted food to the customers and good value for the produce to the farmers. Due to many restrictions during pandemic, it is proposed to sell the produce to the local consumers going with the call of the Prime Minister of India, be local, be vocal about local. The trend of buying locally can be seen in the state of Tamil Nadu.

The suggestion about utilizing community centers aligns with the recently taken decision by the Indian government where farmers are granted more freedom in terms of selling their produce directly to the customers to undetermined prices [2].

Selling the products to the local consumers to a possible extent reduces the risk of long-distance logistics during pandemic and the unavailability of trucks. In our research we recommend the community center as a hub for local customers and farmers and the movement of produce around the hub. Every farmer is trained to use the services of the community center and register his produce with the community center to keep a track of the quantity and quality of produce and the customer's needs. As Russel (2005) and [3] pointed out information systems can help to enhance knowledge and transparency. The intention within India is that farmers will now gain access to information about prices in different states of the country and the prices being offered there [2]. The community center could serve as a support for this proceeding trend in the ways that education and training can help to advance farmers' knowledge in the field of market dynamics and finance. Plenty of research has been published on the need of education so that farmers can be helped to self-help. Even if the literacy rate in Tamil Nadu is above countries average 80,09% (in rural areas it proves to be 67,7%) (Ministry of Human Resource Development, 2016) it is necessary to increase knowledge amongst farmers in order to be able to fully profit from the decisions made by the Indian Government.

It's inevitable that farmers learn about topics such as multi-cropping, market dynamics or financing as well as about sustainability in terms of protecting resources.

The community centers serve as a logistics location for shipments to regional markets. According to [4] it is necessary to describe clear tasks and responsibilities in order to be able to mitigate risks during disasters but also to enhance the process of collaboration within the supply chain. Our model adheres to that. Community centers maintain a record of the area of farming, the farmers contact details, the produce (vegetables, fruits, greens) and the quality of the produce. Again, the importance of an information system has to be mentioned here. To support the processes in terms of transport booking and payment we use existing technology as f.eg. Lynk and Gpay, the applications would be used to connect the farmers, community center, trucks, and the customers.

Payment to the farmers, community center and the truck drivers will be through online payment modes (recommendation to Gpay). One most acknowledge that there's a high competition on the Indian market when it comes to digital payments. Singh (2019) describes that up until today only a fraction of small and medium size enterprises use Gpay. Other competitors have even lower numbers. For making the suggested model work, farmers need to educate in the usage of digital payment. It cannot be expected that they will use the payment method without the support of community centers. As experience and interviews showed, it is of importance that applications can be used in the local language. This cannot be fulfilled yet, as the existing technology doesn't provide the language option "Tamil". As a long-term solution this customized app will have the capacity to manage funds between community center, farmers, drivers, local customers and regional markets.

Tamil Nadu has the lowest temperature of 25C during the year and the highest with 33C [5]. Another proposal is the utilization of shipping containers with a cooling system run by solar energy. Yet the remark has to be made that solar panels still are very expensive and is therefore not an option for large

scale usage. Another way of preserving the produce in the community centers is using dry ice which costs Rs 55 per kg (less than a dollar per kg) [6].

The table below shows the optimal temperature for produce in order to enhance shelf life.

TABLE III
OPTIMAL COOLING TEMPERATURE

Produce type	Opt. Tem °C	Storage life
Apples	1 - 4	Up to 12 months
Bananas	13-16	Up to 3 weeks
Grapes	0	Up to 8 weeks
Broccoli and cauliflower	0	Up to 4 weeks
Carrots, mature and immature	0	Mature, up to 9 months and immature up to 6 weeks
Onion, white and red	0	Up to 8 months
Mango, orange, potato and tomato (ripened)	4- 8	Up to 12 months

VI. CONCLUSIONS

Farmers in India, especially in Tamilnadu have incurred great loss due to transport issues, lack of storage facilities, inclement weather and lack of demand. Due to the pandemic lockdown the available transport is very less, and the demand has also shrunk due to the closure of restaurants, schools and universities. This article has highlighted the necessity to have a community centred approach to ensure a holistic, resilient solution to the existing problem. The solution provided in this article is suitable to be implemented during any natural disaster or a pandemic. A well-coordinated information system makes sure that the farmers are connected to the truck drivers, customers and community centers so that their products are made known to the customers and the supply chain is not disrupted. Products from the farmers reach the customers either through road, or rail or sea. This multi-linked approach gives various options to the farmers to find the right customers. Storage facilities proposed at the community centers help to increase the shelf life of the produce. Bio fertilizers used also helps in increasing the shelf life of the produce.

- Through community centred approach we ensure that processes can be planned in a more advanced way as stated as necessary in the literature review
- We took information systems into consideration
- Promotion and acceptance is still a way to go, it needs local stakeholders who want to proceed with this
- The usage of two different apps (Lynk, Gpay) is not ideal and also in future it makes sense to differentiate in the payment terms?
- Fear of COVID-19 can hardly be taken away. In these times education and support from community centers are evident
- Usage of technology has its limitations as gpay technology is used but could be used to a larger extend
- It's a small-scale approach where it is relied on community. Trust, confidence and proceeding together is the core

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