LEAN START-UP MANAGEMENT
(MGT1022)

DIGITAL ASSIGNMENT – 3

SUBMITTED TO:

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Question 1: Lack of a coordinated transport system has put farmers into big trouble. Many times, apples from Himachal Pradesh or potatoes from Nagpur, do not reach the markets on time and the farmers lose a lot of money in business. Present a well-coordinated transport system to help farmers across India.

1.1. Introduction

For the last couple of years, farmers from Himachal Pradesh and Maharashtra have been facing severe transportation problems, mainly due to poor architecture and bad roads, resulting in the hindrance of staple vegetables and fruits transportation, primarily HP's juicy apples and Nagpur's potatoes, even though the states are set to produce a record harvest.

Farmers are rightfully saying that commuting has become difficult on the slushy roads. In HP, small and marginal farmers, including Dalits and Muslims, residing in Jubbal-Kotkhai, Rohru, Theog, Rampur, Chopal, Karsog-Gohar-Churag-Chatri in Mandi in Kullu are resorting to premature harvesting of the fruit. They fear that they might lose their orchards in view of the ongoing encroachment drive. On the other hand, Nagpur's farmers are losing almost 10-15% of their potato produce every season, since they have to hold their reserves in their local Mandi for an extended period of time, resulting in their spoil since maintaining the optimal condition for their sustenance is not always feasible.

Transportation is one of the important marketing functions required in apple and potato marketing because consumers are situated at longer distances from producing areas. Transportation involves bringing produce from orchards to the road head and then road headers to consumers. Often family and hired labour are used for carrying the product from orchards to assembling points. After doing packing at the assembling point, the produce is carried to road-head either on human backs or on the mules. From the road-head, after doing appropriate marketing motorized transport is hired for taking the produce to local or terminal markets.

An analysis of grower problems revealed that the major concern is high transport cost. A further concern is about the lack of all-weather and metallic roads. Many farmers feel the need for improved link roads in the producing areas. Nearly 45.71 per cent of farmers of a recent study reported that their villages are not linked with proper metalled link roads. In hilly terrain during the rainy season landslides and road blockage, take place.

One farmer added, "Let alone heavy vehicles, even small vehicles cannot pass the roads." Adding pain to misery, heavy monsoon rains have turned the loose sliding mud from the hillsides into pools of slush and ruts causing frequent roadblocks and huge traffic jams. Usually, it takes about 3 hours to travel on the 100 km hill road but now often takes 8 to 10 hours say, farmers.

1.2. Literature Review

[1] Farmers' choice of market channels and producer prices in India: Role of transportation and communication networks

Authors: Digvijay S. Negi, Pratap S. Birthal, Devesh Roy, Md. Tajuddin Khan

Journal: Food Policy, ELSEVIER, Volume 81, December 2018, Pages 106-121

In this research paper, the authors assessed the effect of transportation and communication networks on farmers' choice of market channels for staple vegetables like potatoes, etc. and subsequently on the prices they receive from these channels. It is found that due to delays in transportation, smallholder farmers sell more to informal channels i.e. local traders and input dealers, and typically receive lower prices from them compared to the government-set minimum support prices (MSP). The prices realized from the sales in regulated markets are also less than the MSP despite these being claimed to be more transparent in price discovery.

Econometric results show that farmers' access to transportation and information enables them to obtain better price terms from informal as well as formal channels. The effect of information is relatively stronger, implying that farmers' access to transportation itself is not sufficient but is effective when combined with the provision of market information.

Further, the authors proposed that despite a positive impact of the improved market access on price realization from informal traders, farmer-trader relations are unlikely to undergo a meaningful change because of the tied transactions involving inputs, credit, and outputs.

Finally, the transportation systems need to be mandated and financial institutions need to improve their outreach to smallholder farmers to reduce their dependence for credit on local traders and input dealers who often tie it with output sale, and extract rent by paying less than the market price. The high incidence of interlinked transactions particularly for the smallholder farmers and the negative effects on farmers' price realization necessitates this.

[2] A Study on Farmers' Marketing Strategies for Agricultural Produce and Problems Faced by the Farmers during COVID-19 Lockdown

Authors: P. Bayya Reddy, M.S.R. Mariyappan

Journal: Int. J. for Innovative Engineering and Management Research, SSRN, October 2021

In this paper, the authors showed that there is a fall in the supply of agricultural products because of lower demand (due to the Covid-19 lockdown), and as well as due to severe transportation cut-off. The pandemic triggered the imposing of restrictions on movement and closure of state and national borders affected the transportation of agricultural produce from farms to markets. With the closure of local mandis, farmers were unable to sell their produce in physical marketplaces. Hence, the farmers have endeavored to market their produce in village markets and semi-rural towns with their own marketing strategies during the Covid-19 lockdown.

However, farmers continued to sell their produce timely despite disruptions at every stage of the Agri supply chain with their unprecedented marketing practices during the Covid-19 lockdown period owing to unavailability of transportation and closure of local mandis. Therefore, it is paramount to understand what viable marketing strategies were used by farmers to sell out their agricultural produce during the lockdown. In this study, it has been ascertained that there is a plight in the farmers to market their harvest during the lockdown.

Due to restrictions on movement and transportation, most of the farmers' produce stays within villages and remains largely unsold. Therefore, the prices of agricultural supplies continue to fall and force most of the farming families into debt. However, the farmers have made tremendous efforts to sell off their supplies with their unprecedented selling strategies. Besides, a virulent strain of corona has taught the farmers a lesson of the way of supply chains and selling off their supplies during unfavourable conditions.

[3] Problems and Constraints in Marketing, Production, and Transportation of Apple Crop in Himachal Pradesh

Authors: Firdous Ahmad Wani, Manoj Songara

Journal: European Journal of Research, Life Sciences div., May 2019

The study in this research paper was conducted in Shimla and Kullu districts of Himachal Pradesh State, based on higher area and production of the apple crop. The mission of the agriculture extension system is to transfer and deliver knowledge to farmers. Major problems faced by apple growers in production were a shortage of technical labour, lack of desired chemical fertilizers and plant protection chemicals, financial issues, massive transportation problems, and irrigations problems. Challenges faced during the marketing of apple fruit were lack of cold storage, market supply, and demand knowledge, lack of transport and communication channels. The study emphasized the need to develop the proper marketing and processing facilities before its cultivation is popularized on a large scale in the State.

Small scale apple farmers lack regularity in terms of production for the markets due to insufficient access to production resources. With the increase in the production of apples in both districts of Himachal Pradesh faced many problems in the field of marketing of apples and their

products are needed arising between farmers. An effort has been made to analyze the issues faced by the apple growers in the surroundings of marketing and production. The production problems faced by the farmers in the district of Shimla and Kullu were recorded during the sample survey.

It is concluded that one-half of the population in the two tribal districts does not have any proper marketing knowledge and those who have such experience get it from other sources like neighbours and friends in the majority. The banking and storage facility in the study area is almost negligible. Risk and delay in payment are the reasons which are responsible for preferring the local market for selling apple fruit. The people of both districts are preferred to sell their apple crop to local contractors as they are easily approachable for getting payments. It is concluded that the majority of people carry apple fruit by themselves or through animals and labours as the roads are not connected with fields of farmers. It has been found that the majority of the respondents are most of them are not aware of such help.

[4] An economic analysis of postharvest losses, marketing, and transportation issues of potato

Authors: Abhineet Ranjan, Jayant Zechariah

Journal: The Pharma Innovation Journal, 2018; 7(12): pages 391-394

Researchers in this study has examined the post-harvest losses, marketing, and transportation issues of potato in rural Maharashtra. Multistage cluster sampling has been used for the selection of 6 potato growers' villages, and 110 respondent farmers. The sample has also included 10 market functionaries. Potato has been selected for the study. The maximum aggregate post-harvest losses have been found at the producer level followed by wholesalers and retailers. There was no organized market for potatoes.

The marketing cost, marketing margin and price spread of potato were lowest in short marketing channel (Producer-Consumer) and highest in longest marketing channel (Producer Pre-harvest contractor Wholesaler Retailer Consumer). The study has suggested that the establishment of producer co-operatives to handle various activities relating to the production and marketing of vegetables would help in reducing post-harvest losses.

The findings of the investigation have been presented under a couple of objectives: 1. To find out the socio-economic profile of potato growers in the study area. 2. To assess the post-harvest losses of potatoes at different marketing stages in different farm size groups. 3. To estimate the marketing costs, margin and price spread in the marketing of potato through different marketing channels. 4. To identify the marketing problems and measure to minimize post-harvest losses. The study has suggested that the establishment of producer co-operatives to handle various

activities relating to the production and marketing of vegetables would help in reducing post-harvest losses.

[5] Economics of Marketing of Apple Crop and the Problems Faced by Growers in Himachal Pradesh

Authors: Isha Sharma, Amit Guleria

Journal: Economic Affairs, AESSRA, June 2020, Vol. 65, No. 2, pp. 285-293

In this study, the authors have examined the marketing and price-spread patterns of the apple crop, alongside their transportation problems in the state of Himachal Prades. A few policy interventions have been suggested for promoting apple crops in the state. The present study has been carried out in the two purposively selected blocks i.e., Banjar and Naggar of Kullu District of Himachal Pradesh by taking a representative sample of 70 farmers.

The produce has been found to be marketed through four channels and maximum i.e., about 59 per cent has been disposed of through channel B (Producer-primary wholesaler-secondary wholesaler-retailer- consumer). Comparison between different channels revealed the highest share in consumer rupee in Channel D (Producer- retailer-consumer) i.e., 73.95 per cent. followed by channel A (Producerwholesaler-retailer-consumer) i.e. 60.28%, Channel B (Producer-Primary wholesaler-Secondary wholesaler-retailer-consumer) i.e. 56.24 % and C (Producer-Pre harvest contractor- Primary wholesaler-Secondary wholesaler - retailer consumer) i.e. 50.00 %. Marketing efficiency has also been found to be highest in channel D i.e. 2.84 which means the smaller the channel more profitable it is. Apple being a perishable product incurs huge post-harvest losses. Lack of good infrastructure and availability of skilled labour was found to be the major problems faced by the apple growers in the study area.

In order to minimize the losses, steps are required for quick disposal of the produce using improved techniques of refrigeration, proper storage and improved packing material, maintenance and expansion of the network of link roads must get added attention. Non-availability of sufficient market information to apple growers also affects the operational efficiency of the apple markets as a consequence of which the growers miss the opportunities to sell their produce at remunerative prices, in the right place and time. In this regard, credit and crop insurance of apple cultivation should be provided through formal institutional sources so as to lessen the grower's dependence on traders and improve bargaining power in the market. The practice of e-marketing could be used to increase the marketing efficiency in the apple trade.

[6] Production, Transportation, and Marketing Efficiency of Apple Farming: A Study in Shimla and Kullu Districts of Himachal Pradesh

Authors: Firdous Ahmad Wani, Manoj Songara

Journal: ICMR, May 2019

This study was conducted in Shimla and Kullu districts of Himachal Pradesh. The primary data was collected from 200 apple growers of the Kullu and Shimla districts. The production efficiency of apple was analysed by using the stochastic frontier production function. The study revealed that the inputs, viz., the density of plants per hectare, fertilizers, organic manure and labour were the four significant variables positively influencing apple yield. Among the five marketing channels prevailing in the study area, channel II (Grower – Retailer – Consumer) was the most efficient channel as indicated by the modified marketing efficiency. The major production constraint faced by apple growers was inadequate irrigation and finance problems while the major marketing constraint faced by them was lack of storage facility and malpractices in the market.

The data for the study included both primary and secondary. The primary data for the study was obtained from the sample apple growers through a personal interview method with the help of a pre-tested schedule. The help of Assistant Horticulture Officers of the Department of Horticulture, Shimla, HAREC (Hill Agricultural Research and Extension Centre, Bajaura) and local traders were availed in contacting the farmers as this instilled confidence in the minds of the farmers to provide reliable data. The analytical tools made use in the study are SPSS and MS Excel for the efficiency of apple crop and modified marketing efficiency analysis.

The packaging of a product is important to protect the product from damage besides information about the product that attracts customers. Its needs are more emphasised in the case of processing apple marketing, since low standard packaging may cause health hazards. It has been found that major problems faced by the farmers in terms of packaging and grading systems are shortage of well-trained labours, higher wages of labours, unavailability of labours and strict labour union rules.

Apple cultivation now has become economical, valuable, job creation and profitable in recent years. It produces more than 10 lack jobs directly or indirectly. A study of the production, transportation, and marketing aspects of apple in detail is one of the greater importance to Himachal Pradesh. The present study was a modest attempt by the authors to analyse the production efficiency and marketing efficiency of apple and the constraints in production and marketing of apple in Shimla and Kullu district of Himachal Pradesh.

[7] An Inquiry into the Problems of Apple Production, Marketing, and Transportation in the Perspective of Apple Growers in Shimla District of Himachal Pradesh

Authors: K Kireeti, L.R. Sharma

Journal: Int. J. of Agricultural Science & Research, Aug 2017, Vol. 7, Issue 4, pp 7-14

The main goal of the authors working on this research paper was to analyse the production, identify the transportation problems, and marketing allied problems of apple growers in Shimla district of Himachal Pradesh. The study sample of the apple growers by randomized technique was 70 people. The results indicated that apple growers have serious problems in the production stage related to labour, cost and availability of fertilizers & chemicals. Also, there are limitations in marketing related to lack of specialized labour, packaging material, malpractices, storage problems, transportation and market intelligence.

Problems of apple growers in Himachal Pradesh are coupled up with the deplorable condition of roads. There was a virtual breakdown of the administration in the apple belt of Shimla and marketing of produce had become a nightmare for the growers who had to put up with unending traffic jams, shortage of trucks, exorbitantly high freight charges and potholed roads. The growers were being made to pay two times than normal fixed by the government. The apple-harvesting season coincides with the monsoon and growers have been putting up with landslides, market crashes and other problems every season.

Apple growers' awareness about apple production and marketing was at an average level. Therefore, agricultural educators and the concerned organizations in society must pay attention to these problems and have a particular agenda to solve the same in due course of time. In the study area, nearly 78.57 per cent of farms reported that their villages are not linked by all-weather roads. 42.86 per cent of farms of the study area voiced a high transport charge. During the peak season of horticultural operations, there is a tendency to ask for higher wages performing the marketing operations.

1.3. Design Thinking

1.3.1. Understanding The Problem

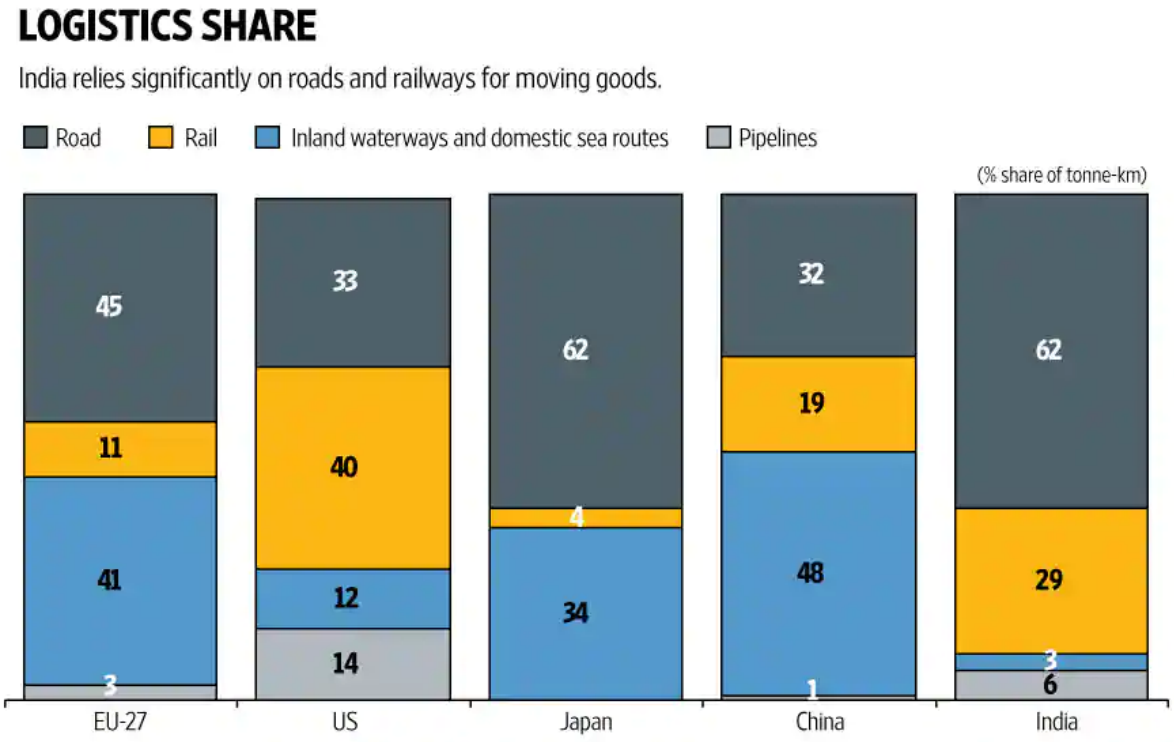
A well-coordinated transport system helps in the sustained economic growth of any country. This holds true for India as well. The Indian transport system comprises several modes, including roads, railways, shipping, air transport, etc. India boasts one of the world's largest road networks, spread over 3.3 million kilometers, and the largest railway system under a single management. However, the access has not been uniform.

India's transport and logistics infrastructure challenge can be summarized in 4Cs: Cost, Congestion, Connectivity and Convenience. According to studies, India spends about 14% of its GDP (gross domestic product) on logistics which is 40-60% more than what countries such as Singapore, Germany, the US and Japan spend. This is the single-biggest hurdle in making India globally competitive. Congestion is another challenge, driven by concentration of economic activity in a few cities, long delays in new project delivery and suboptimal planning of existing infrastructure assets.

While solving cost and congestion are important for driving growth and prosperity, ensuring uniform connectivity and convenience in all parts of the country is essential for enabling equitable and inclusive growth. Public transport, which is not known for its connectivity or convenience, is still the only means of transport for the poor. It allows the poor to look for work opportunities and gives them access to education and health services. Over the years, a lot of focus has been on building traditional transport infrastructure, and rightly so, but the time to shift gears and reimagine the country's transport needs is now.

1.3.2. Analyzing And Interpreting A Plan

India relies significantly on roads and railways for moving goods. For example, 62% of cargo is moved on roads, 29% by railways and a meagre 3.3% by domestic sea routes and inland waterways. According to BCG's analysis, the cost of moving goods by rail and inland waterways is much lower than by roads. It costs Rs2.6/tonne-km to move goods by road—the comparable numbers for railways and sea and inland waterways is about half at Rs1.4/tonne-km and Rs1.1/tonne-km, respectively. We have structurally set ourselves for higher logistics costs. Unlike India, most countries have developed modes that keep costs of operations low.



1.3.3. Ideate (Imagine, Research, Ponder)

- Make the most of existing infrastructure

While building new infrastructure assets ranks high on the national agenda, it is important that we make the most of existing infrastructure. Until recently, “operational efficiency" was an uncommon term in the infrastructure sector because, for most government entities, there used to be clear directions and targets for new asset creation. However, things are changing and there is increasing realization world over.

Take the major public ports for instance. Over the last two years, these government entities have driven substantial operational efficiencies with changes in policies, mechanization, use of digital technologies, etc. This has doubled their cargo-carrying capacity and reduced vessel turnaround times dramatically.

- Ensure transit convenience for passengers

The world over, urban transport is being planned around transit convenience, i.e. locating the hub terminals of different modes of transport close to each other. This helps passengers move from bulk modes of transport (like rail) to last-mile modes of transport (like buses) easily. Many major cities such as Singapore, Hong Kong, Tokyo and Stockholm have all designed their urban transport around multimodal co-located terminal developments for transit convenience. On the contrary, if you look at the 15 most-frequented railway stations in India, the average distance to intercity bus stations is around 4km. Passengers currently use uneconomical and inconvenient modes of transport to transit from one to the other. Transit inconvenience across these 15 railway stations affects approximately two-three million people daily.

- Encourage disruptive start-ups

Technology disruptions are changing the face of many industries, including transport. Disruptions like predictive analysis, virtual aggregators, remote tracking and control, vehicle-to-vehicle communication (truck platooning: a number of trucks with state-of-the-art driving support systems— one closely following the other), etc., are challenging norms and changing business models in the logistics industry. This shows that modernization of the transport and logistics sector can be achieved without heavy expenditure, and instead the focus can be on improving efficiencies with low capex (capital expenditure).

- Improve rural transport connectivity

Nearly 50% of trips from villages involve the use of a national highway. But the connectivity from the highway usually extends only up to a distance of 5km on either side of the highway. Establishing uniform and deep connectivity is important to efficiently connect the rural economy with its markets. Better connectivity will also give those living in rural India access to better education and health facilities. While the Pradhan Mantri Gram Sadak Yojana is a step in the right direction to create the required infrastructure, it is also important to ensure adequate public transport frequency and quality.

In most states, the state transport undertakings (STUs) dominate the road transport sector. Currently, the total number of STUs stands at 55 across the country with a

total fleet size of 148,000 buses carrying about 70 million passengers daily, almost three times more than Indian Railways, which carries more than 23 million passengers daily. These STUs, barring a few, have been incurring huge financial losses, have below par quality of buses and do not provide the requisite frequency of connectivity. In the past, some efforts have been made to reform these STUs but with limited success. Reforms of STUs need to begin again, especially since this is the largest mode of transport and even a small change will benefit a large section of the population.

1.3.4. Reviewing And Revising

Earlier, transportation development was driven by the respective ministries of railways, roads and shipping. They would all develop their own investment plans. Of late, however, a few steps have been taken with dedicated freight corridors wherein a holistic approach is being adopted. Yet, an integrated transportation plan is needed that ensures that different transport systems are aligned. The split of responsibilities in the management of different transport modes between ministries at the national level inhibits smooth and well-coordinated development. What India needs is a unified transport plan to deliver a multimodal transport system for the farmers to easily get their produce into the nearby and the far-away markets.

1.4. Methodology

The Logistics And Goods sector needs to influence mobility in two ways. Firstly, there is a need to provide effective peripheral road networks to commercial vehicles that travel through a city only to head to another destination. Secondly, there is a need to redesign the warehouse network in urban areas so that congestion due to commercial vehicles entering the city due to the current location of warehouses and modal transit points can be avoided. One example is Azadpur & Sahibabad farming regions in Delhi, which have been amalgamated with the city's stretching limits resulting in greater congestion as trucks cross busy city roads. An additional issue is large commercial vehicles driving through urban roads and expressways during "no-entry" timings. Solutions under this theme, therefore, aim to address the current and emerging challenges in logistics and goods transportation. Globally, freight accounts for 10-15% of vehicle equivalent kilometres travelled in urban areas. Furthermore, urban freight costs for intra-city travel are more than twice as expensive as long-distance freight.

In order to address the challenges through a concerted effort, the proposed solutions are organized across a set of three core themes as follows:

1. Optimize vehicle flow through populous urban areas
2. Design optimal warehousing & intermodal network
3. Maximize load utilization

Each theme and its supporting initiatives are outlined below, supported by the required strategic levers and relevant global benchmarks across developed and developing economies.

1.5. Diagrammatic Representation

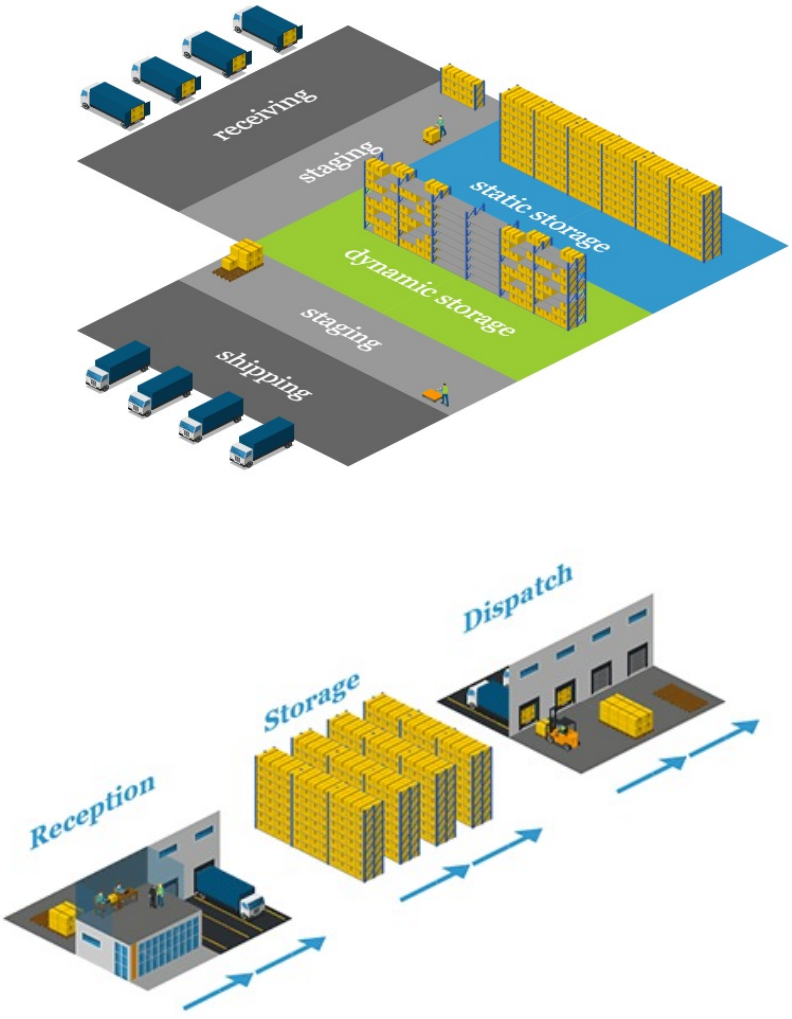


Fig. Optimising Warehouses (Mandis)

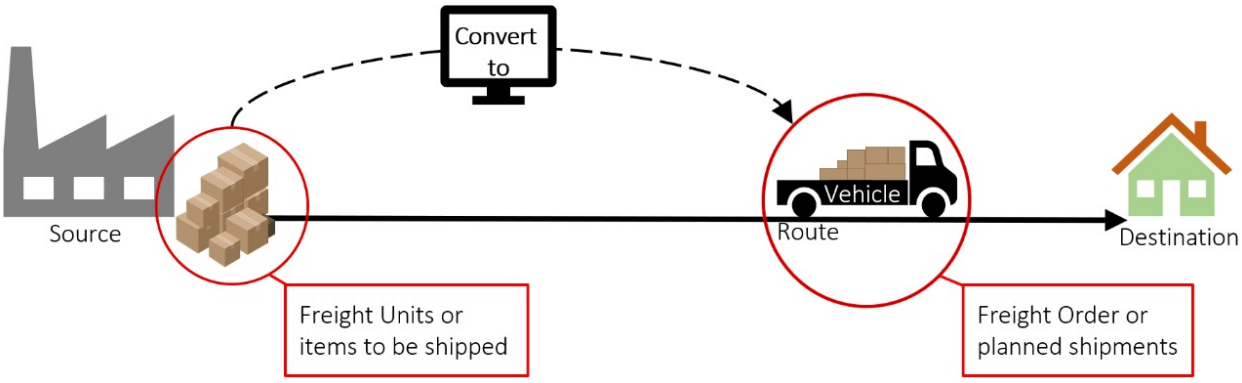


Fig. Optimizing Vehicle Flow Through Populous Urban Areas

1.6. Proposed Solution

1.6.1. Optimize Vehicle Flow Through Populous Urban Areas

- Timing and zoning: Identify and enforce norms around freight movement, e.g. dedicated freight routes
  - Strategic lever: A model framework for optimizing freight movement across the country should be developed and cities must adopt this framework with suitable regional considerations.

- Effective feeder network using effective and green last-mile connectivity: Traditional shippers are increasingly towards green freight for last-mile delivery. These vehicles have lower emissions also (can help reduce the environmental damage at the same time) and can enter into narrow city lanes, where the wholesale market Mandis are generally located.
  - Strategic lever: Central government guidelines should be formulated for recommending shippers to deploy a certain percentage of the fleet as green vehicles for last-mile delivery.

1.6.2. Optimize Warehouse Locations and Inter-Modal Network

- Warehouse location strategy: Develop large shared warehouses to serve as consolidation

- Strategic lever: Specific guidelines to enable cities and states to design their customized warehousing strategy should be developed.

- Well-planned, adequate multi-modal logistics and interchange facilities: To further minimize the interaction between commercial and passenger traffic, additional modes should be actively utilized. These warehouses should accordingly provide infrastructure for smooth transhipment of farming produce.
  - Strategic lever: State and city governments to develop multi-modal parks.

1.6.3. Maximize Load Utilization for all Categories of Produce

- Build digital, shared platforms for improving utilization
  - Strategic lever: Enable the creation of a centrally driven shared platform supported by the Government – which aggregates demand across platforms and helps provide fleet transporters, as well as farm, produce transporters in rural settings to improve their utilization.

  - Strategic lever 2: Create a regulatory framework for allowing freight exchange and aggregator platforms to thrive in rural and urban settings. Set guidelines, which include financial support, subsidies, and public awareness campaigns among other enablers to improve adoption of aggregation platforms.

Question 2: Present ways to radically enhance the productivity of irrigation, "more crop per drop" (water conservation).

2.1. Introduction

Population increase and the improvement of living standards brought about by development will result in a sharp increase in food demand during the next decades. Most of this increase will be met by the products of irrigated agriculture. At the same time, the water input per unit irrigated area will have to be reduced in response to water scarcity and environmental concerns. Water productivity is projected to increase through gains in crop yield and reductions in irrigation water. In order to meet these projections, irrigation systems will have to be modernized and optimized.

In a developing country like India, the agricultural sector along with the rural economy play significant roles in providing livelihoods, ensuring food security, and providing momentum to the growth of industries and service sectors. With a population of 1.37 billion, India is the world's second-most populous country. 60.3% of India's arable land employs close to 60% of the Indian labor force, making up for only 18% of the national GDP, and 15% of the total GVA at current prices.

Of the total holdings, 85% fall under the marginal and small farm categories of less than 2 hectares. The average size of landholding has been estimated to be 1.15 hectares. During the last five decades, global agricultural production has increased at an average annual rate of 2.5-3%. The slowdown in agricultural growth has become a major cause for concern. India's total rice yields are one-third of China's and about half of Vietnam and Indonesia. The same is true for most other agricultural commodities.

The uncertainties in growth in agriculture are explained further by the fact that more than 50 percent of agriculture in India is rainfall dependent which aggravates the production risks. Climate change must also be cogitated as more extreme events – droughts, floods, erratic rains – are expected and would have significant impacts in rain-fed areas.

2.2. Literature Review

[1].Improving Irrigation Water Use Efficiency: A Review of Advances, Challenges and Opportunities in the Australian Context
Authors:Richard Koech , Philip Langat

This paper reviewed the advancements made towards improving irrigation water use efficiency (WUE), with a focus on irrigation in Australia but with some examples from other countries. The challenges encountered, as well as the opportunities available, are also discussed. The review showed that improvements in irrigation infrastructure through modernisation and automation have led to water savings.

The concept of real-time control and optimisation in irrigation is in its developmental stages but has already demonstrated potential for water savings. The future is likely to see increased use of remote sensing techniques as well as wireless communication systems and more versatile sensors to improve WUE.

In many cases, water saved as a result of using efficient technologies ends up being reused to expand the area of land under irrigation, sometimes resulting in a net increase in the total water consumption at the basin scale. Hence, to achieve net water savings, water-efficient technologies and practices need to be used in combination with other measures such as incentives for conservation and appropriate regulations that limit water allocation and use.

Challenges that might be encountered include lack of public support, especially when the methods used are not cost-effective, and reluctance of irrigations to adopt new technologies.

[2].Methods and technologies to improve efficiency of water use
Authors: Robert G. Evans , E.John Sadler

This paper analyzes the current competition for existing freshwater supplies will require a paradigmatic shift from maximizing productivity per unit of land area to maximizing productivity per unit of water consumed. Water can be conserved at a watershed or regional level for other uses only if evaporation, transpiration, or both are reduced and unrecoverable losses to unusable sinks are minimized (e.g., salty groundwater or oceans).

According to the authors, agricultural advances will include implementation of crop location strategies, conversion to crops with higher economic value or productivity per unit of water consumed, and adoption of alternate drought-tolerant crops. Emerging computerized GPS-based precision irrigation technologies for self-propelled sprinklers and microirrigation systems will

enable growers to apply water and agrochemicals more precisely and site specifically to match soil and plant status and needs as provided by wireless sensor networks.

Agriculturalists will need to exercise flexibility in managing the rate, frequency, and duration of water supplies to successfully allocate limited water and other inputs to crops. The most effective means to conserve water appears to be through carefully managed deficit irrigation strategies that are supported by advanced irrigation systems and flexible, state-of-the-art water delivery systems.

[3] Increasing Productivity through Irrigation: Problems and Solutions Implemented in Africa and Asia

Authors: Daria Mashnik , Headley Jacobus, Amer Barghouth , Eva Jiayu Wang

This paper presents three major interconnected problems inhibiting the spread of irrigation in Asia and Africa: lack of access to water, lack of access to energy, and lack of access to finance. This paper also discusses how these problems are interconnected, complicating the use of technological solutions to address these problems.

For food production to keep pace with population growth and resist the effects of climate change, the expansion of irrigation to non-irrigated farmland is critical. Innovative, affordable, and easy-to-implement technologies are needed for smallholder farmers to irrigate efficiently, mitigate greenhouse gas emissions, and help adapt to the effects of climate change.

Through the examination of seven case studies in Asia and Africa, this paper finds that new irrigation products and services must include appropriate technology, sales, service, financing, and revenue collection in order for them to be widely adopted by underserved communities.

[4] Smart Irrigation System for Optimized Use of Water and Energy

Authors: Dr H I Joshi , P P Raval, Kush Patel

In this paper the author described about smart irrigation system using microcontroller and sensors is presented to optimize the use of water for irrigation as well as reduce the wastage of electricity. The system presented in this work can be operated from anywhere in the world. It is not required for farmer to be present at farm for irrigation purpose. Farmer can operate the system and know the status of farm regarding irrigation at anytime from anywhere in the world

using his mobile. This low cost smart irrigation system with some modification can also be applicable to gardens for optimized use of water and electricity.

The system presented in this paper is useful for the optimal use of water in the farm. User can know the status at any time by sending the request through mobile phone. If submersible motor runs without water, moisture sensor will send signal immediately to microcontroller to prevent any damage to the motor. This smart irrigation system is designed for small farm. It can be designed with some modification for any size of farm.

In this work a smart irrigation system is presented that uses microcontroller, soil moisture sensor, rain drop sensor, GSM module and other miscellaneous components. This low cost system allows user to operate it from anywhere so user need not to be present at farm for irrigation purpose.

[5] Constraint-based innovations in agriculture and sustainable development: A scoping review

Authors: Janet Molina-Maturano , Stijn Speelman, Hans De Steur (2019)

This review covered less explored attributes of the adapted Technology Acceptance Model: the design, direction and scale of the innovation (Agarwal et al., 2017). It was found that apart from NGOs, multinational companies (MNCs), governments and universities, farmers and locals are also able to initiate the innovation processes with support from collaborative initiatives. The importance of innovation networks, such as the Honey Bee Network in India (Gupta et al., 2016), during early phases and for scaling up is highlighted. This review went over 30 cases of constraint based agricultural innovations.

The results also indicate that there is a need for further research on the integration of frameworks, such as the Technology Adoption Model (TAM) and the Sustainable Rural Livelihoods (SRL), to link constraint-based innovations with sustainable development at a local level. Also, a framework is proposed for practitioners, as a starting point, to identify and research agricultural constraint-based innovations and their potential impact on sustainable development.

This paper goes on to show that in India, innovation and knowledge networks have supported innovations related to agricultural equipment, e.g. by providing funding and patent consultancy.

[6] More crop per drop

Authors: S. Carriger, Domitille Vallee (2007)

This review shows that In some cases, improving irrigation efficiency is the most appropriate way to reduce non-beneficial depletion—to save water. But a common mistake is to look at water savings only from the narrow point of view of irrigation efficiency at the farm or irrigation-system level—ignoring the larger basic phenomena of water recycling and multiple uses of irrigation water that are prevalent in many systems. For example,seepage 'losses' from canals and fields may recharge aquifers and shallow dug wells used for domestic water supply.Irrigation drainage water is often captured and reused by farmers or it reenters the river system to be used downstream.

Increases in water productivity are necessary to solve many of the problems of the water crisis, but they are not sufficient. It is imperative that these be accompanied by a poverty focus to help the poor reap the gains of increases in water productivity.Attention needs to be given to establishing and maintaining access to water for domestic uses and income- generation, affordable water-productivity-enhancing technologies, and giving the poor a voice in water decisions.

2.3. Design Thinking

Empathize

When water is plentiful, growers usually schedule irrigation practices around other farming activities. For example, most growers change furrow irrigation sets at 12- to 24-hour intervals because this timing is convenient and uses labor efficiently. However, long irrigation sets can waste water. When water is in short supply, you need to rethink some practices to obtain maximum benefit from available water. After all, next to the land itself, water is a grower's second most important resource. It makes sense to exchange management and labor for water use efficiency. Because irrigation districts must keep their systems charged with water, these practices have a greater impact as more growers use them. Even when water is more plentiful, there are compelling reasons to use less. Excessive water use can waste soil and fertilizer in water runoff. Excessive irrigation results in deep percolation and leaching of nitrates, nitrites, and other farm chemicals. These contaminants contribute to the total daily load of chemicals carried by aquifers.

Define

Until recently, the choice of technologies available to farmers was largely determined by the need to increase production, profits and productivity. The main constraints were the availability of capital, knowledge of how to use the technology and market risks — risks that in many countrie's policies were shielded by government policies. In the past, "good policy practices" was therefore rather straightforward, relating primarily to increasing output and the aim of agricultural policies was to increase productivity in agriculture. Agricultural research and extension services could concentrate,for example,
on improving the productivity of small farms. Now agriculture has to fulfill diverse objectives: it needs to be internationally competitive, produce agricultural products of high quality while meeting sustainability goals. In order to remain
competitive, agricultural producers need rapid access to emerging technologies. Farmers are faced with many more constraints — and also more opportunities. In addition to being profitable, they need to meet environmental standards and regulations, as well as deal with direct and indirect consumer and
lobby group pressures. They may also be flooded with information from various government and industry sources, that make choosing appropriate technologies more difficult.

Ideate

Approaches to using less water

You can improve irrigation efficiency by irrigation scheduling, adopting practices such as deficit irrigation and conservation tillage, and installing more efficient irrigation systems. Sprinkler and drip irrigation systems are more efficient than furrow irrigation. Some of these strategies entail additional costs, but they can also lead to higher market value of crops.

Avoid over-irrigation

This sounds simple, but it isn't. Many growers err on the side of excess. Too much water has less visual impact than too little, but it wastes soil and fertilizer as well as water.
Eliminate deep watering of shallow-rooted crops such as onions and beans. Frequent, light irrigations help keep water and mobile nutrients in the root zone where plants can use them.

There is a seasonal demand pattern for water, which varies by crop. The optimal time to irrigate a particular field also depends on when the crop last received water and the soil water holding capacity.Irrigation scheduling can be done based on soil water content or soil water tension. Use soil-moisture monitoring equipment to measure how much moisture is in the soil. There are several types of sensors available. The soil water content sensors used most commonly in the Pacific Northwest are neutron probes and capacitance sensors. The most common soil water tension sensors are granular matrix sensors and tensiometers.

Prototype

One of the possible solutions for this problem statement can be Micro Irrigation which serves the purpose of water conservation as well.

The main objectives of Per Drop More Crop (Micro Irrigation) are as under .

- Increase the area under micro irrigation technologies to enhance water use efficiency in the country.
- Increase productivity of crops and income of farmers through precision water management.
- Promote micro irrigation technologies in water intensive/consuming crops like sugarcane, banana, cotton etc and give adequate focus to extend coverage of field crops under micro irrigation technologies.
- Make potential use of micro irrigation systems for promoting fertigation.
- Promote micro irrigation technologies in water scarce, water stressed and critical ground water blocks/districts.
- Link tubewell / river-lift irrigation projects with micro irrigation technologies for best use of energy both for lifting and pressurized irrigation as far as possible.
- Establish convergence and synergy with activities of on-going programmes and schemes, particularly with creating water source for its potential use, integration of solar energy for pressurized irrigation etc.
- Promote, develop and disseminate micro irrigation technology for agriculture and horticulture development with modern scientific knowledge.
- Create employment opportunities for skilled and unskilled persons, especially unemployed youth for installation and maintenance of micro irrigation systems.

Test

Micro Irrigation technology e.g. drip and sprinkler irrigation including drip fertigation to increase productivity of crops with less water should also be popularized with adequate support from the Government.. Needed credit facilities should be available to the farmers to pay for the equipment.Our soils are not rich in nutrients and hence supply of sufficient and balanced nutrients to the soil through Integrated Nutrient Management will enhance soil health and the yield of the crops. Particular attention is needed to the supply of micronutrients like zinc, boron and sulfur.
Since water shortage is experienced in different seasons, promotion of crop diversification with high value but less water requiring crops like pulses and oil seeds and multiple uses of water will enhance crop yield and income of the farmers. Hence demonstrations and adaptive research programmes will be very useful-Farmers normally face price uncertainties. Hence, adequate support for marketing and market information be given to farmers. Suitable models of farming systems, i.e., crop-livestock integrated farming should be encouraged and experimented with farmers participation.

Since, crop insurance will safeguard farmers during weather uncertainties, introduction of weather based crop insurance for minimizing the losses to farmers is also recommended. A credit linked development plan for homogeneous areas can be prepared in coordination with banks, farmers, traders, processors, exporters, NGOs, Panchayats and Government Development Departments.

2.4. Methodology

The following hurdles have to be tackled by our solution:-

- Insufficient Yield:- Increased yields, diversification to higher-value crops, and the development of value chains to lower marketing costs are all factors that must be exploited to boost productivity

- Irrigation:- The proportion of net irrigated area to total cropped area is 34.5 percent, making a major portion of agriculture reliant on rainfall. There must be ways to dramatically increase irrigation productivity ("more crop per drop"). Water management on the farm might be improved, as well as the use of more effective delivery techniques such as drip irrigation.

- Climate Change:- Predicted temperatures and India's recent precipitation trends lead to projections of farm revenue losses ranging from 15% to 18% on average, rising to 20% to 25% in unirrigated areas. At present agricultural revenue levels, that equates to more than Rs. 3,600 per year for the average farm family. India needs to expand irrigation, and it needs to do it in the face of rising water scarcity and diminishing groundwater supplies.

- High Cost:- The majority of Indian farmers work on unprofitable land and cultivate it using conventional ways. As a result, they are vulnerable to the hazards of poor agricultural cycles and are usually always in debt. Farmers who become in debt as a result of crop failures, low earnings, or money-lender malpractices risk never getting out. 'Inherited debt,' in which farmers inherit or pass on debt to the next generation in addition to inherited property or land, makes up a major portion of farmer liabilities. This loop can be broken by increasing the quantity of institutional loans available to farmers.

  So when proposing a solution, we have to keep these hurdles in mind. Our proposed solution will keep in mind the climate change that has had a major on the agricultural yield here in India. Also we can go with sustainable solutions like Solar PV pumps as one of the reasons that has hampered the productivity, profitability, and efficiency of agricultural and agribusiness operations is a lack of reliable energy for irrigation. Solar PV pumps are one solution that many entrepreneurs are turning to. Using solar PV pumps will allow us to tackle the problem of having no reliable source of energy for irrigation.

2.5. Diagrammatic Representation

The block diagram of the proposed system is presented here in Fig. 1. In proposed system ATMEGA328P microcontroller is used. Soil moisture sensor, rain drop sensor, LCD display, and GSM module are interfaced with ATMEGA328P microcontroller. Soil moisture sensor, raindrop sensor and dry run sensor (another soil moisture sensor is used for this purpose) give analog signals proportional to moisture level to the microcontroller.

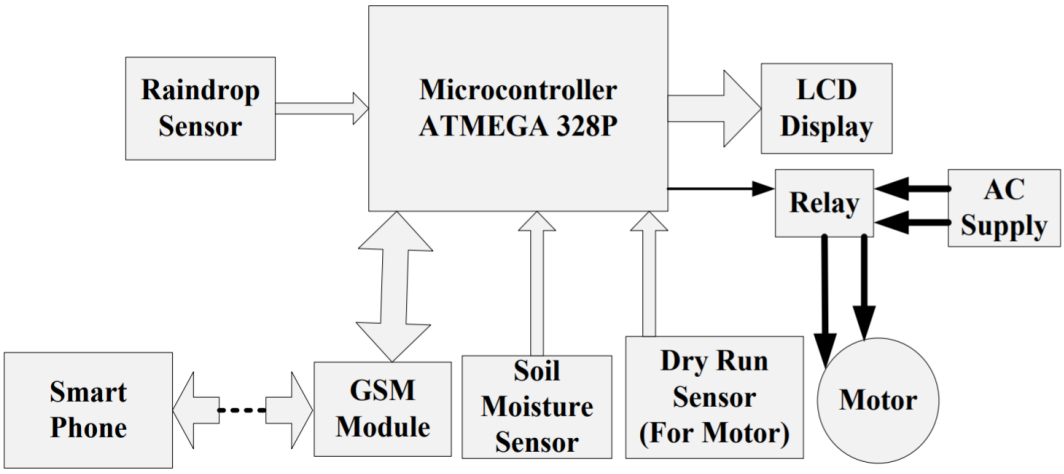


Fig. 1 Block diagram of proposed strategy

2.6. Flow chart of proposed smart irrigation system

The flowchart based on which the microcontroller program is made is presented in Fig. 2. Microcontroller continuously checks for any message sent by user. Controller receives such messages (through GSM modem) and takes appropriate decisions.

In some conditions if no any messages received from user, controller takes appropriate decision and then sent message regarding it to the user. User can know the status (of percentage soil moisture, submersible pump, rain etc.) by sending the SMS to system.

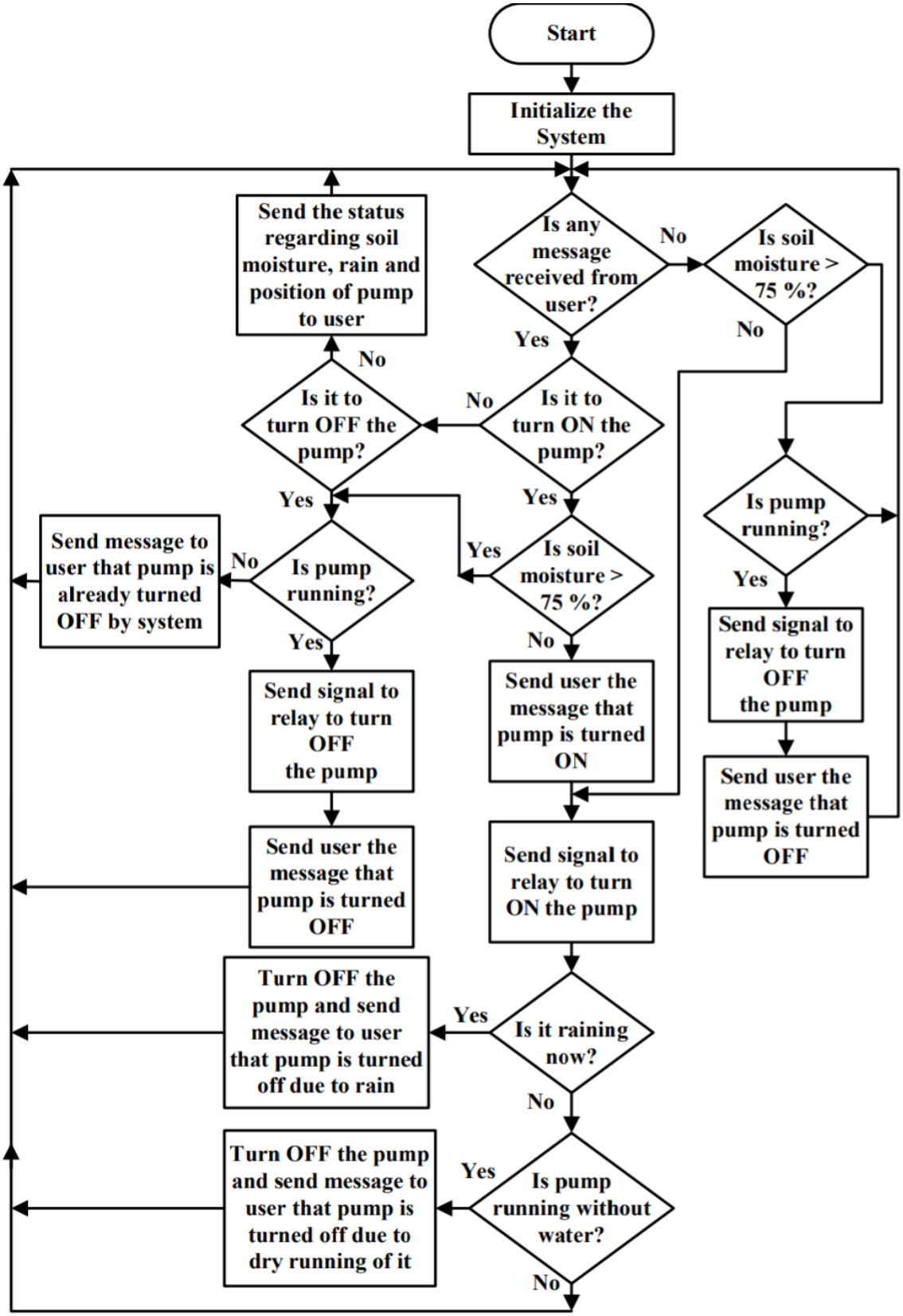


Fig. 2 Flow chart of proposed system

2.7. Proposed Solution

Microcontroller converts this analog data into digital value and compares the current data with set value of moisture level. If current value of soil moisture is more than the set value microcontroller sends signal to relay to turn off the submersible pump. Another moisture sensor or dry run sensor is used to sense the presence of outlet water of the submersible motor. If there is no water in the outlet pipe, submersible motor must be stopped otherwise it will be overheat. Raindrop sensor also gives analog data proportional to intensity of rain to the microcontroller. Microcontroller converts this analog data into digital value and decides the presence and intensity of rain. If it is raining sufficiently microcontroller sends signal to relay to turn off the submersible pump. This stops immediately unnecessary wastage of water as well as electricity. Using GSM module microcontroller receives the command sent by farmer. Through GSM module data regarding soil moisture and rain are sent to the user. Hence remote operation of the system becomes possible using GSM module. LCD display shows current status regarding soil moisture, rain and submersible pump.

Description of hardware used:-
The major components used in the system are described in short here.

1. Soil Moisture Sensor: This sensor senses the humidity or the moisture of the soil. The change in humidity is proportional to the amount of current flowing through the soil. It is presented in Fig.2.

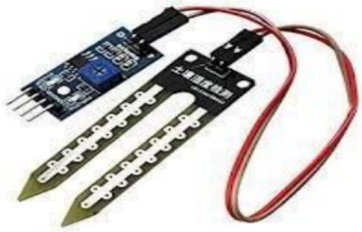


Fig. 2 Soil Moisture Sensor

2. Microcontroller ATMEGA 328p: It has 14 digital input/ output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. This single chip 8 bit microcontroller has 32kb flash memory with read/write features. It has 32 general purpose working registers, and 3 flexible timer counters.

3. Raindrop sensor: It is a tool that senses presence as well as intensity of the rain. It consists of two modules, a rain board that detects the rain and a control module, which compares the analog value, which is given to the microcontroller. The raindrop sensors can be used in the automobile sector to control the windshield wipers automatically also can be used in the agriculture sector to sense presence of rain. It is presented in Fig. 3.

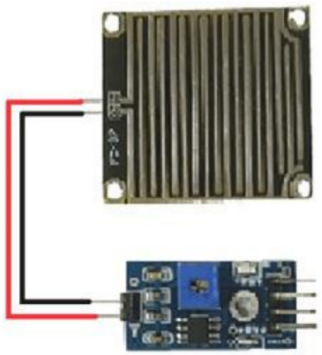


Fig.3 Raindrop sensor

4. GSM/GPRS Modem: It is a class of wireless modem, designed for communication over the GSM and GPRS network. Using AT commands data can be sent or received through this modem. It is presented in Fig.4.

Fig. 4 GSM/GPRS modem

5. LCD Display (16x2): This is used to display the current statistics of the system.

6. Submersible Pump: Submersible pump having 18 W motor is used here for testing of the proposed system.

7. Arduino IDE 1.8.1 software is used in this work.

If user wants to turn on the submersible motor, he has to send the text “PON” to the system through SMS. Microcontroller checks this message and after checking the soil moisture level it sends signal in relay to turn on the submersible motor. If user wants to turn off the submersible motor, he has to send the text “POF” to the system through SMS. Microcontroller checks this message and sends signal in relay to turn off the submersible motor. The set value of soil moisture is 75% in this work. Hence if soil moisture level becomes more than 75%, pump automatically turns off and message regarding this event is sent to user on his mobile phone. Suppose submersible motor is running and suddenly rain starts, motor will turn off immediately

and message regarding this event is sent to user on his mobile phone. If user is far away from the farm and wants to know the status of the farm, he has to send the text “STA” to the system through SMS. Microcontroller checks this message and sends various data regarding current status in reply to the user.

The system presented is useful for the optimal use of water in the farm. User can know the status at any time by sending the request through mobile phone. If submersible motor runs without water, moisture sensor will send signal immediately to microcontroller to prevent any damage to the motor.

This smart irrigation system is designed for small farm. However it can be designed with some modification for any size of farm. It can also be used for small or big gardens with some modifications. If flow sensor is used to measure consumption of water, data regarding actual usage of water can be send to user as well as to Government irrigation department for monitoring purpose.