PAKISTAN'S REER INDEX HITS EQUILIBRIUM

By

Salman Siddiqui, Karachi

Further gain in rupee, inflation may make exports uncompetitive

Pakistan's real effective exchange rate (REER) hits equilibrium. However, a further appreciation in rupee against a basket of major trading partners' currencies and increase in domestic inflation reading would make the country's exports uncompetitive.

The REER index increased 3.37% to 100.50 in March 2021 compared to 97.22 in February, Pakistan's central bank reported on Thursday.

REER returned to over 100 reading on the index after over two years. A further increase in the rate would make Pakistan's exports uncompetitive and would make imports cheaper. REER increased after the rupee-dollar exchange rate hit 22-month high at RS152.75 to the US dollar on March 31 and inflation surged 9.1% in March.

REER has continued to increase for the past seven month (Sep-Mar). It stood at 91.78 reading on the index in August 2020. A REER below 100 means the country's exports remain competitive and import expensive. The situation reverses when REER stands above 100 on the index.

"The latest REER number suggests the rupee should not appreciate beyond RS155 to the US dollar (considering inflation remains stagnant)," an expert who requested anonymity said while talking to The Express Tribune.

"The REER stood at around 130-140 on the index during former finance minister Ishaq Par's times (when he artificially controlled the rupee and kept it overvalued during 2008-13)" Topline Securities Director Research Syed Atif Zafar recalled.

Pak-Kuwait Investment Company (PKIC) Head of Research Samiullah Tariq said inflation has played a key role in moving the currency from overvalued (REER at 97.22 in February) to a fair value at present.

"Currently, the State Bank of Pakistan is using (currencies) weight of 37 major trading partners and competitors of Pakistan for REER calculation. These weights represent not only bilateral trade volumes, but also a competition in the third markets," according to a central bank video explaining REER's concept, construction and interpretation.

"For example the weight of China in the index is 29.12% (in the index), it not only represents trade volume between Pakistan and China but also competition between Pakistani and Chinese firms in a third market like the USA," it said.

"The REER reading on the index in a range of 100-105 would be fine," the expert said, adding that the authorities concerned may opt to let the rupee depreciate to not let REER increase beyond 105.

The expert, on the condition of anonymity, said he does not agree with the theory to depreciate the local currency to control REER. Instead, authorities should take measures to attract foreign currencies' inflows to improve REER through attracting foreign investment, increasing export earnings, surging conventional remittances and the ones through Roshan Digital Account (RDA).

He said that authorities should keep focus on economic growth and expansion to make REER sustainable. "The desired higher economic growth would help the country in generating higher revenue in taxes and payoff local and foreign debts. This formula would automatically keep REER sustainable," he said.

Tariq said REER of regional competitors including India and Bangladesh have reached 125-130 readings on their indices. The higher food prices and increase in energy prices like petroleum products and RLNC have contributed a lot towards taking inflation on higher side at world and impacted REER

Zafar said that REER has increased due to widening trade deficit, meaning imports have continued to surge rapidly, while exports improved at a slower pace. "The REER reading at 100.5 on the index is fair. This is no alarming situation as of yet," he said.

EXPLORING WORLD'S BIGGEST MARKET

Ahmad Mukhtar & Hira Nisar Khan,

Islamabad

Economic, trade policy makeover is required to increase Pakistan's exports to EU



ADVANTAGES: A diverse export base could help Pakistan multiply the benefits of being one of the only eight countries which have the GSP+ status from the EU.

Economies determine the standing of nations in the world while markets determine the power.

Reliance and belief in the power of markets is certainly gaining ground over mere political slogans in international relations.

With its population of 450 million, in 27 countries, the European Union (EU) is the largest economy and the largest trading bloc in the world. The current foreign and trade policy of Pakistan does not seem to be internalising the aforementioned fact. There is, however, still time and margin to improve.

Pakistan's total share in EU's imports was merely 0.3% in 2019, despite having the CSP Plus status, and that too was mostly in textiles.

For the EU market, the list of largest import partners starts with China, followed by USA, the UK, Russia, Switzerland, Turkey and on the 10th place is India while Pakistan ranks in the 40s.

A positive point, however, is that between 2013 and 2019, Pakistan's exports to the EU increased by 65%. This is still far less than the potential.

Flipping the story to the side of Pakistan, the EU is Pakistan's largest export market, taking up 35% of the export share. This resonates to feel even higher, realising that

almost one-third of Pakistani imports finds a market in the EU, a statistic which speaks of its own importance.

Top exports, from Pakistan to the EU, include textiles, raw animal skins, vegetables, foodstuff and tobacco. The volume of exports has been on a rising trend since 2011 but the share in EU imports remains at 0.2-0.3%, which states that the size of the EU market is growing but not the share of trade between the EU and Pakistan.

A significant point to be noted is the absence (or negligible volume) of services' exports from Pakistan to the EU.

It is no-brainer that the manufactured and processed goods carry the value addition in their sale prices that raw skins, textile yams, unprocessed goods and vegetables do not.

One, however, may not find a logic why Pakistani exporters do not consider this for the European market, which is a "premium" consumer market. There is enormous potential for the manufacturing sector and high-skilled labour to contribute to value-added exports from Pakistan.

Preferences and standards

Training and specialisation by the skilled labour and deployment of latest machinery would be required to ensure Pakistan's textiles and leather accessories meet the aesthetic preferences of the EU market; cutlery, surgical and pharmaceutical instruments are all designed and produced as per the European standards; and exotic herbs, spices as well as Basmati rice, cane sugar, fertilisers, Himalayan salt, and fruits are packaged according to quality packaging standards of the EU.

Stitched, printed, embroidered and tailoured for the EU sizes apparel would make more contribution. Marbles, tiles, leather goods and artwork such as carpets and Kashmiri Pashmina would need export regulatory policies to increase compliance with international standards of quality and production.

Emphasis on quality packaging of international standards for foodstuff and edible products would increase the opportunity for processed foodstuff exports. Bringing foreign investment via partnerships with European clothing brands would give a big boost to Pakistan's textile exports.

To strengthen relationship from its side, the EU has granted Pakistan the Generalised Scheme of Preferences Plus (GSP+) status. Based on this status, around 80% of Pakistan's exports to the EU are quota and tariff-free, hence, having an advantage over many other competitors.

Currently, Pakistan's exports are mainly composed of textile but there is potential for many more products under the GSP+. This gives Pakistan a potential goldmine to diversify its export base.

A diverse export base could help Pakistan multiply the benefits of being one of the only eight countries which have the GSP+ status from the EU.

Policy revamp

Before the EU can be regarded as more than just trade partner, Pakistan needs to first realise the importance of this trade partnership. A strong commitment to

developing exports and an economic and trade policy makeover is required to capitalise on this potential and increase export earnings through "Made in Pakistan".

As the EU is also one of the main "development" partners of Pakistan, there needs to be a revamp of Pakistan's policy and approach towards the bloc so that it takes a comprehensive and holistic approach, combining economic, diplomatic and development policies. In a globalised world, highly competitive and proactive trade policies and export development need to be in place in order to gain entry into potential markets.

Doing so requires market study, spotting opportunity, knowledge of competitors' strategy and reshaping one's skillset and investment to optimise one's resources and outperform competition -something one feels quite less in trade policy of Pakistan.

With a large labour force, land area and untapped natural resources, Pakistan can learn lessons from its eastern neighbour and focus on revamping its economy and shape a trade policy where the country achieves trade-led economic growth and ranks amongst top producers and exporters of the world.

Why not aim for a situation where "Made in Pakistan" becomes a mark of recognition and quality and an essential component in the global supply chains.

ENERGY SECURITY: SOME SUGGESTIONS

SHAHBAZ KHAN, Islamabad

High-profile advisory council comprising energy professionals should be set up



UNEXPECTED ISSUES: LNG supply chain has started throwing up unique challenges including sometimes even impacting supplies from the country's own fields, photo: ROTTERS

Energy security appears to be the biggest challenge confronting the country since long. The following paragraphs are an attempt at a quick health check of Pakistan's energy supply chain and recommending the way forward.

Despite all of our cash flow issues and heavy debt, we have somehow ended up with a highly lethal energy mix which compels us to spend around $16 billion on fuel imports annually-The main reason is that during the past more than 40 years, instead of considering a long-term strategy and its execution, we have mostly reacted to crisis.

A few examples are failure to build any major dam after Tarbela Dam in 1976 and Thar coal taking decades to commence its monetisation-though its effective utilisation could substantially increase the reserve life of oil and gas.

Similarly, despite negligible progress on gas reserve replacement, we continued to use it liberally. The optimal use of indigenous resources could help in delaying the import of expensive liquefied natural gas (LNG). The replacement of oil and gas reserves requires a sustained focus on the exploration and production (E&P) activity. We instead have not been very consistent in this regard.

Hardly 35% of the country has so far been explored with the last major hydrocarbon discovery in 2002 in Tal block.

Lack of interest by most of the E&P MNCs for the past 15-20 years adds to the challenge. Pakistan has a rich past with respect to the presence of MNCs such as UTP, BP, Occidental, BHP, Tullow, OMV, Premier, BG, etc. Only a few such as MOL, PCNiC, UEP and Eni are still active in Pakistan.

In addition to E&P, the MNCs contribute to imparting modern knowledge and skills to the country's professionals who serve as employees or interact with expatriates in joint ventures and other forums like PPEPCA.

This, in conjunction with other factors, went a long way towards maintaining excellence at high levels in the E&P industry for a long time. However, the gradual exit of MNCs is causing a marked dent in the entire process.

Challenges of midstream and downstream industries have also increased with time. Unaccounted-for-gas (UFC) and associated losses stood at 358 million cubic feet per day (mmcfd) in FY19, ie equivalent to sales of a large gas field.

Similarly, the LNG supply chain, still in its infancy, has started throwing up unique challenges including sometimes even impacting supplies from our own fields.

We have not so far been able to achieve the refining capacity as per requirement, thus compelling us to meet at least 45% of requirement for petroleum products (20 million tons per year) through imports.

The transmission infrastructure for oil and petroleum products also needs augmentation. It goes without saying that the planned addition of Machike to the Taru Jabba pipeline (initially conceived in 2000) is an apt step in that direction. Appropriate solutions to indigenous crude oil transportation are required.

A number of countries having dearth of oil and gas have made huge investments in E&P abroad to augment their energy security. However, we are far behind in that direction as well as in establishing strategic underground oil and gas reserves.

The above observations indicate that at least some aspects of the country's energy supply chain need more focus.

India and Bangladesh

Both countries appear to be galloping towards their energy goals. ONGC of India has targets to double its gas production by 2040. It drills more than 500 wells a year with 50 offshore wells. Pakistan hardly drills 80 wells per year. ONGC has assets outside India in 17 countries contributing 200,000 barrels of oil equivalent per day. Oil India is active in 10 countries.

India has plans to invest $100 billion in oil and gas infrastructure by 2024. With 23 large refineries, it has refining capacity of 257 million tons per year, which generates annual revenue of $35 billion from the export of petroleum products. Also, it has three underground oil storages.

Bangladesh's gas production has gone up from 1,744 mmcfd in 2009 to 2,700 mmcfd and the aggregate supply including re-gasified LNG is 3,250 mmcfd.

It established a robust LNG supply chain in less than three years, ie two terminals each of 500 mmcfd, supply contracts and transmission capacity, while further expansion is in progress.

Bangladesh has especially done wonders in electricity generation and transmission. It increased generation capacity four times from 5,000 megawatts in 2009 to 21,000MW by 2019 and targets to reach 60,000MW by 2040.

What is to be done?

Until the above situation is dealt with in a holistic manner with a long-term plan and a dedicated team capable of supporting implementation of such a plan, "fire-fighting" may continue to consume most of our time and resources.

Therefore, a state of energy emergency is required to be declared immediately along with the constitution of a high-profile advisory council comprising world-class energy professionals (engineers, geoscientists, etc) who have managed large value chains. Some immediate tasks of the advisory council can be as follows:

First, conduct an integrated review of the oil and gas supply chain gaps, along with a concomitant study of power supply issues and options (including coal), develop remedial plans and support their implementation.

Second, make baseline capacity assessments of relevant components, including the governance and institutional framework, of supply chains and corresponding catch-up plans, and support their implementation.

Some international references such as that of Norway, South Korea, Singapore, China, etc may come in handy in this homework. Third, approach all E&P MNCs which are still in Pakistan or have left and ascertain their candid feedback with respect to what can/could retain them.

Fourth, nurture a culture of professionalism. We have no future without fulfilling this essential requirement. This requires capacity gap mapping of human capital requirements and focused capacity-building plans including opportunities for the exposure of professionals to international systems and corporate environments.

A number of countries such as Singapore, South Korea and China are examples of the progress possible in short periods by investing in human resources. Advisory councils have played a vital role in expeditious development of a number of modem economies. Therefore, there is no reason for its failure in Pakistan.

The above suggestions assume critical urgency because 64% of Pakistan's population is between 18 and 30 years of age. Also, the ratio is projected to stay the same for the next 20 years.

Therefore, it is imperative to respond to the needs of the youth bulge with the fastest possible socioeconomic development which, of course, necessitates a robust energy supply chain.

ARTIFICIAL INTELLIGENCE IN NEURAL NETWORK PROGRAMMING AND LEARNING

By

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The scope of this article is to understand Artificial intelligence its uses, applications, advantages and disadvantages in a general way from our daily life examples and basic concept of application of AI in Neural Network Programming and learning.Let us first define the terms artificial and intelligence. Artificial means any thing which is not natural and created by humans and term intelligence means the ability to understand, think and learn. When we combine these two terms together, we get artificial intelligence (AI). AI is broad area of computer sciences where we have computer machines behave like human intelligence. The main objective of AI is to mimic the human brain and ingrain intelligence in machines so that machine can act intelligently and independently same like human brain. Let's take a look on human brain before we discuss about AI. Human brain functions independently, make decisions, take input from environment and keeps on updating knowledge. Human brain functions can be segregated in different functions like communication, logical reasoning, problem solving, storing and retrieving experiences and updating memory and displaying and controlling emotions. If we just talk about communication, human brain is performing many different functions simultaneously while communication brains use subconscious memory to retrieve linguistic vocabulary and phrases and bring them to conscious memory, relate words to experiences and convert words into sounds and tempos by using vocal chords, body gesture and expression control. Now how brain knows all this, actually brain has capability to observe things using visionary organs, hearing capability, touch, taste, smell and other social and natural interactions in other words we can say we are equipped with different sensors to interact with our environment. Our brain is programmed for running our body, organs and maintaining the ability of continual understanding, thinking and learningthrough organs or sensors which create intelligence in humans. The ability of learning in humans are open ended due to its independence in inferencing from logics and exercising logical reasoning to reach to conclusions and day to day decision making which keeps on updating human intelligence and ultimately the knowledge.Intelligence is something that makes the man superior to all the other living beings on this earth. The human is made to be the most intelligent living thing to exist which can feel, sense and see things and have its own perception and views. How can we not expect it to prove its intelligence through passive ways?

Artificial intelligence is a term coined by John Mccarthy in 1955 at the Dartmouth conference and was defined by him as "the science and engineering of making intelligent machines". But how can we make machines intelligent?

To answer this question, we will have to understand the importance of decision making in our actions. We are always doing decision making, name anything you

can find that you need to make decision, in fact your life is all about decision making like what to say? What language to use? What words to select? What tone to use to utter those words? What expression to show? What gesture to display? If you deeply analyze each second of your life you will find that you are continuously in decision making state every moment. Some decisions are logical and simple programmed like mathematical calculations and other are complex and involve emotions. When we program machine in a way that it can make decisions that lays foundation stone for artificial intelligence. To better understand use of machines as intelligent tools let's discuss an example like you visit physician for some ailment or sickness, what actually medical practitioner does? Physician checks your vitals, symptoms, see test results and related that information with medicine properties and select best suited medicine and suggest medicine. What if we have programmed a machine who in a same way collects all information from patient using forms, voice recognition, sensors and then based on stored information suggests medicine? Can that machine replace the role of physician and act as an expert system? The answer is upto major extent yes, this is an example of artificial intelligence.

Now we discuss artificial intelligence in technical terms to discuss AI in more specific way. Most often the two terms artificial intelligence and machine learning are used interchangeably, but in actual they are different. Artificial intelligence is a broader term and machine learning is part of artificial intelligence. We can say all machine learning is AI but not all AI is machine learning.

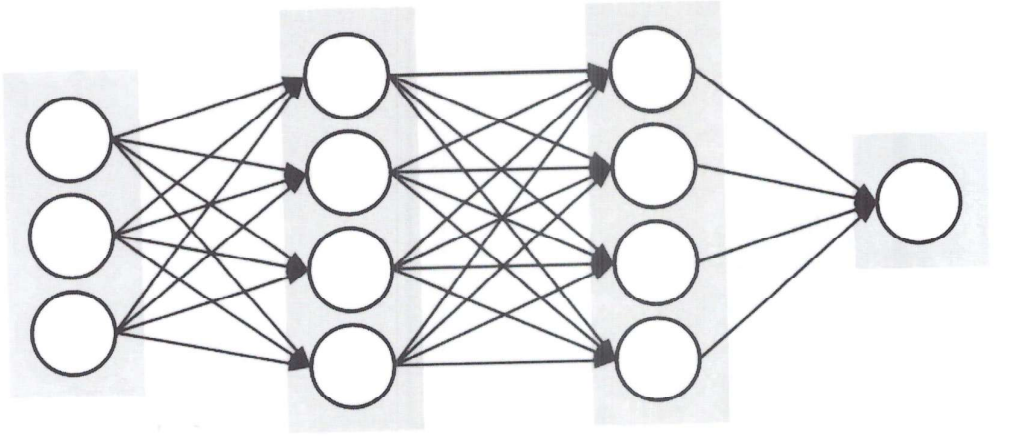
AI has many different building blocks applications which includes but not limited to:

1. **Expert Systems**(ES) –ESare systems which has capability to act as an expert. They cannot absolutely replace experts but they provide significant support to experts in their work.
2. **Natural language processing (NLP)** - NLP is a branch of AI that deals with study of how machines can understand human language. The main objective is to develop systems that can understand text and can perform translation, grammar checking, topic classification or other related operations like humans do.
3. **Speech Recognition** - Speech Recognition is a capability which enables machines or programs to understand human speech and convert that into text format and subsequently that can be used to activate commands, translations into different languages or other task as humans use their voice to perform different operations.
4. **Computer Vision**– Computer Vision is a capability of machine to visualize, interpret and understand the visual world. This is used by the machine to accurately identify, locate objects and process to react using cameras, videos etc. like humans do by using eyes.
5. **Robotics** – Although robotics and AI are not same thing but robotics can be made more intelligent using AI. AI is part of large robotic system like use of sensors, actuators and other algorithms to make robots intelligent.
6. **Automatic programming**– Automatic programming is a capability to understand the problem and convert that into logics and programs and

execute as per requirements. This enables machines to step up into solve logical reasoning not exactly but similarly like humans.

There are many other applications to support AI, we have discussed above only few of them to explain how different applications form ears, eyes and other senses for machines to interact with environment the concept is more or less like humans as they have five senses to interact with environment.

The human brain is one of the wonders of the world and human system are guided through evolution of thousand and thousands of years to learn the logics and how to analyze and conclude out of them. Human brain uses neurons to receive information from environment through sensors and form neural network and apply different algorithms to understand. Neurons interact with each other using electrical pulses or spikes and information moves back and forth for different combinations before our brain comes to a final conclusion. Human brain is very complex and is yet to be explored completely, however, Artificial Intelligence inspired by the functionality of human brain has stepped into the field of Neural Network Programming and Learning which has laid a foundation of deep learning.In neural network programming the perceptron is used to represent neuron, in other words we can say the perceptron is an artificial neuron and is a basic unit of neural network. Biological neuron in brain carries electrical spikes receives signals axons of other neurons whereas perceptron is a mathematical model of biological neuron to form neural network in AI. Now, let us discuss how neural network works in AI.Let us see how the machine will learn to compare pattern and will predict the output. The neural network consists of different layers of neurons which are the core processing units of the network. The first layer is the input layer which receives the input.To explain the input layer let us consider example of visual learning, let us see how machine takes input to learn about shape using neural network to identify basic shape. Just imagine if there are three shapes namely square, circle and triangle. Let say each shape consists of 28 X 28 pixels that mean there are 784 pixels now if machine is supposed to compare and differentiate square out of these shapes.In our case the input is 784 pixels so there 784 neurons and our input layer will consist of 784 neurons.The output layer is the layer which predicts the final output.In between there are many hidden layers which are used for the computations to reach to output.



The arrows in between neurons are called channels, each channel is assigned with some value based on some logic called as weight. Each neuron in the input layer is multiplied with weights and the sum of total associated channels is sent to neurons in hidden layer where each neuron is associated with some numeric value called as Bias which is added to the propagated value. The final value of each neuron is then passed to an activation function to determine if that particular neuron is activated or not. The Activated neurons are then transmit data to the next layer of neurons over the channels and in this manner the data is propagated through the network in hidden layers. This is called forward propagation. The neurons in output layer gets data from network with higher values and determine the output based on the values, it is more like probability analysis. The predicted output is then compared with actual output and error is determined and is sent back to the network for the network learning this is called backward propagation. This forward and backward propagation provide learning to neural network to refine the output to match the actual output.

Summing up above discussion about Artificial Intelligence, neural network programming and learning we can say these are the techniques to make machines intelligent to act as humanlike as possible. The research in this field is at very basic stage and the knowledge about human brain is incomplete so this will have to go through the stages of evolution and world will witness the wonders of Artificial Intelligence in the time to come.

DEVELOPMENT OF INNOVATIVE ROTATION PLAN ANALYSIS TOOL FOR EFFECTIVE MONITORING OF HAKRA CANAL SYSTEM, SOUTH PUNJAB-PAKISTAN

By:

Dr. Muhammad Riaz[1], Muhammad Kamran[2], Wasif Yousaf[3]

ABSTRACT

Surface water supply operations and canal operations in Pakistan are based on heuristic approaches. This heuristic management technique often depends heavily on expert human judgment. Pakistan also has one of the world's most complex supply-based irrigation networks. Water distribution within the network is challenges due to water shortages. Shortage of irrigation water is a contest normally occurs at canal tail-end user. The rotational plans only become applicable when the system is bearing the capacity constraints or shortages in water supply. To overcome these problems, Excel Based rotational plan analysis tool has been developed to evaluate the rotational programme in the canal system for effective canal monitoring system. For this study, Hakra Canal System with a command area of 1.4 million hectares has been selected. The results show that among all channels, flood channel has less DPR and on weekly basis analysis, group C channels taking 11% more share in week 2. Similarly, in week 22 only group C channels are getting their fair shares.

Keywords: Canal Management, Water Shortages, Rotational Program

1. INTRODUCTION

The Punjab irrigation system faces numerous constraints that may limit the canal operations. Ahmed, Mahmood, and Munir (2015) stated that Punjab Irrigation System is one of the world's largest systems comprising 13 barrages and 26 main canal systems and 12 link canal systems with overall length of main and branch canals of about 6,500 km, and 2,794 distributaries and minors with overall length of about 31,050 km. GINI coefficient has been widely used as an indicator for the estimation of water distribution equity. Numerous research studies such as Melkamu & Bannor 2015, Cullis and Koppen 2007, Anwar & Haq 2013 and Anwar, Bhatti & de Vries 2016, have supported its usage in this particular context.

The rotational plans are mostly applicable up till the distributaries heads. The direct offtakes of channels are always brought into rotational. Only a couple of rotational plans exist in the system in which minors have also been rotated. On the contrary, main canals, branch canals and link canals themselves are never rotated unless any one of them is being fed by a channel that is under rotation. For example, in case of Sadqia division, Sadiq Ford Feeder acts as a distributary and feeds Fordwah Branch in the Fordwah division during the Rabi season. Sadiq Ford Feeder is being rotated under the Sadqia Rabi rotational plan which consequently brings Fordwah Branch

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under rotation. Moreover, rotational plans are strict and cannot be violated. The total number of priorities in the plan would always be equal to the total number of groups or subgroups, whichever is greater. Further, the number of unique waras will also be equal to the total number of priorities. It should be noticed that a group cannot repeat itself under a specific priority rank unless all the other groups have individually acquired that position in consecutive waras. As for the wara duration is concerned, the length of wara in the Punjab irrigation system varies from 7-8 days. It may be even shorter than the aforementioned time frame, however, such instances are quite rare. Adding more, there are two seasons in a year, Kharif and Rabi. Each season comprises of approximately 24 weeks and independent rotational plan is proposed for each one. It should be noticed that ideally, the number of times a group acquires the first position in the rotational plan for the whole season should be the same for every group. The shortages should be distributed equally among all the groups.

Due to introduction of high yield seeds and the increase in cropping intensities, the colonial era water allowances are presently inadequate and hence the farmers frequently face water scarcity issues and involve in water thefts, tampering the outlets, and exchanges in warabandi (fixed turn water distribution quota) times (Awan, Anwar, Ahmad and Hafeez, 2016). Due to water security issues, water is distributed in IBIS on equity basis and for this purpose, a rotational plan is used in the irrigation canal system. Mishra et al. (2001) reported that the rotational irrigation system is a common phenomenon is South Asia to distribute water (Shende and Sachin,2006) addressing water security issues. Therefore, for efficient management to minimize the effect of shortage of water supply at the tail end of an irrigation canal, monitoring of the canal through innovative tools is a dire need. The main objective of current study is to analyses the rotational program of a canal system for effective management and monitoring.

2. METHODOLOGY

2.1 Study Area

Hakra branch canal offtakes receive irrigation water from Eastern Sadqia canal which extracts water from Sulemanki Headworks. The design discharge of Hakra Branch Canal is 2900 cusecs with total cultivable command area of 1.4 Million hectares. Length of the canal is (285433 ft) 87 km as shown in Fig-1. The Major crops grown in the command area of Hakra Branch Canal include wheat, sugarcane, rice and cotton. It has 17 distributaries which convey water from Hakra canal to the farmers' fields via a network of water courses and farm channels. Mostly in the discharge measurement has been taken at Reduced Distance (RD) 2+000 and at 285+000 tail of Hakra branch.

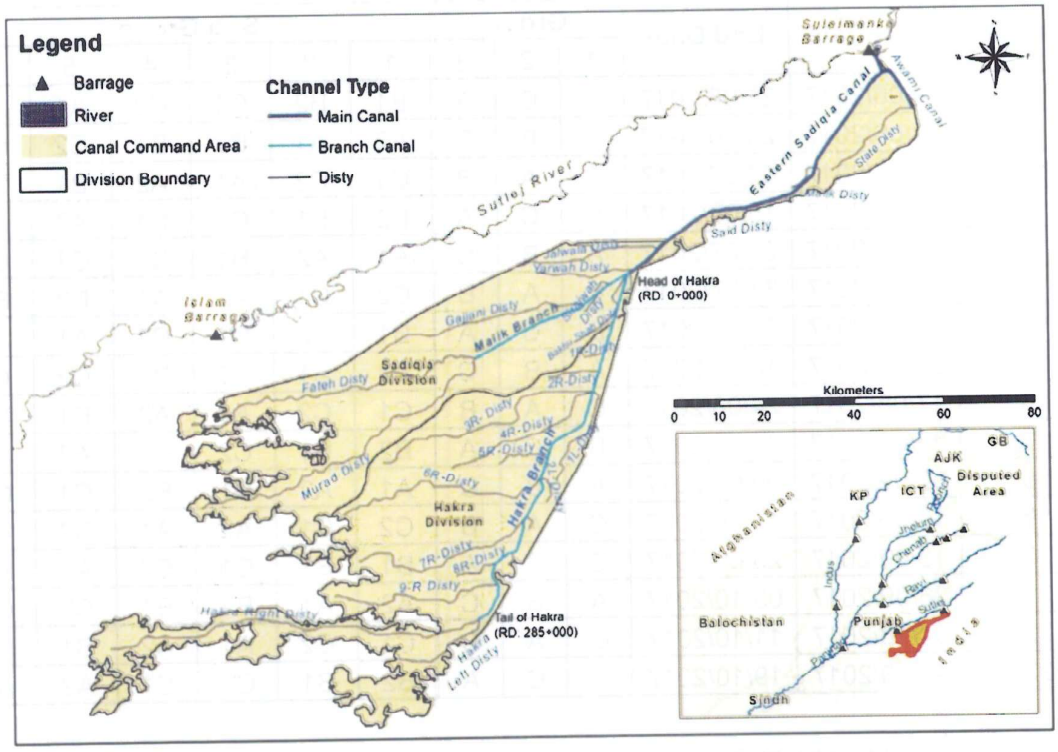

Figure-1: Study Area Map of Hakra Branch Canal Area

2.2 Data and data source

For the study purpose to evaluate the rotational program all the data given in the following table has been collected from Programme monitoring and implementation unit (PMIU) Irrigation Department;

Table-1: Data and data source

Type of Data	Source	Data Resolution
Rotational Programme	PMIU Irrigation	Seasonal
Canal discharges	PMIU Irrigation	Daily

Table-2: Rotational Program

Week No.	Start Date	End Date	Group			Sub Group					
			1	2	3	1	2	3	4	5	6
1	19/04/2017	26/04/2017	C	A	B	C2	C1	A2	A1	B2	B1
2	27/04/2017	04/05/2017	B	C	A	B1	B2	C1	C2	A1	A2
3	05/05/2017	12/05/2017	A	B	C	A2	A1	B2	B1	C2	C1
4	13/05/2017	20/05/2017	C	A	B	C1	C2	A1	A2	B1	B2
5	21/05/2017	28/05/2017	B	C	A	B2	B1	C2	C1	A2	A1
6	29/05/2017	05/06/2017	A	B	C	A1	A2	B1	B2	C1	C2
7	06/06/2017	13/06/2017	C	A	B	C2	C1	A2	A1	B2	B1

Week No.	Start Date	End Date	Group			Sub Group					
			1	2	3	1	2	3	4	5	6
8	14/06/2017	21/06/2017	B	C	A	B1	B2	C1	C2	A1	A2
9	22/06/2017	29/06/2017	A	B	C	A2	A1	B2	B1	C2	C1
10	30/06/2017	07/07/2017	C	A	B	C1	C2	A1	A2	B1	B2
11	08/07/2017	15/07/2017	B	C	A	B2	B1	C2	C1	A2	A1
12	16/07/2017	23/07/2017	A	B	C	A1	A2	B1	B2	C1	C2
13	24/07/2017	31/07/2017	C	A	B	C2	C1	A2	A1	B2	B1
14	01/08/2017	08/08/2017	B	C	A	B1	B2	C1	C2	A1	A2
15	09/08/2017	16/08/2017	A	B	C	A2	A1	B2	B1	C2	C1
16	17/08/2017	24/08/2017	C	A	B	C1	C2	A1	A2	B1	B2
17	25/08/2017	01/09/2017	B	C	A	B2	B1	C2	C1	A2	A1
18	02/09/2017	09/09/2017	A	B	C	A1	A2	B1	B2	C1	C2
19	10/09/2017	17/09/2017	C	A	B	C2	C1	A2	A1	B2	B1
20	18/09/2017	25/09/2017	B	C	A	B1	B2	C1	C2	A1	A2
21	26/09/2017	03/10/2017	A	B	C	A2	A1	B2	B1	C2	C1
22	04/10/2017	11/10/2017	C	A	B	C1	C2	A1	A2	B1	B2
23	12/10/2017	19/10/2017	B	C	A	B2	B1	C2	C1	A2	A1

3.0 DEVELOPMENT OF ROTATIONAL PLAN TOOL

A mathematical "Post-Seasonal Rotational Plan Evaluation Tool" has been developed that possess the capacity to analyses operated rotational plans. Performance indicators are used to comment on the effectiveness of an implemented seasonal rotational plan in terms of equity in water distribution and the percentage of plan being followed.

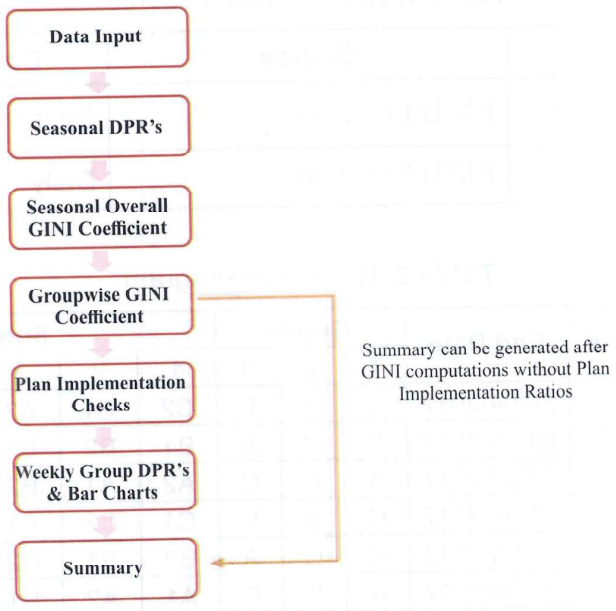

Figure 2: Methodology Flow Chart

Performance parameters in water sharing equity

Performance parameters or indicators are the measurable values that are used to assess the performance of rotational plans in terms of equity in water distribution and percentage of plan implementation. These parameters can assist in performance assessment of irrigation canals and guide water managers to take necessary operational decisions.

3.0.1 Delivery Performance Ratio (DPR)

The delivering performance ratio (DPR) is defined as the ratio of actual discharge to design discharge. If a channel is functioning at a DPR value of 1, it means that the channel is withdrawing its design share. Normally, the irrigation site staff have a cushion to operate a channel up to a DPR value of 1.2. Similarly, channels are not operated under a DPR value of 0.6 so that they are not subjected to siltation.

Where;

$$DPR = \frac{Q_A}{Q_D} \qquad \text{Eq-1}$$

DPR = Deliver performance ratio (unit less);

QA = Discharge at which the channel is being operated (cusecs);

QD = Channel design discharge (cusecs). In case of rotational plans,

QD will be the discharge of the channel that has been allocated in the rotational plan. This discharge might not be equal to the full design capacity of the channel.

3.0.2 GINI Coefficient

GINI coefficient is an indicator that can be used to quantify the equity in water distribution in the system. Its value ranges between zero (0) and one (1). Zero represents a uniform distribution of water whereas one shows fully inequitable distribution.

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{2n\sum_{i=1}^{n} x_i} \qquad \text{Eq-2}$$

Where; G = GINI Coefficient;

x = Seasonal average DPR of a channel;

n = Total number of channels;

i, j = Columns & rows of the matrix.

For user convenience, GINI has been reported in inverse format. This will reverse the evaluation criteria i.e., value one (1) for perfect equality and value zero (0) for inequality.

$$\text{GINI Index} = 100 - x(\%age) \qquad \text{Eq-3}$$

GINI coefficient is a function of channels DPR's and it can only be computed at the completion of the season. Computing a GINI coefficient for a specific wara or number of waras may not provide reasonable results. In case of rotational plans, GINI coefficient will indicate the extent up till which the executed rotational plan was

able to ensure the water equity among the consumers. However, it is important that this coefficient is analyzed in parallel with other performance indicators. A schematic for computing the GINI is shown in the Figure-3 below:

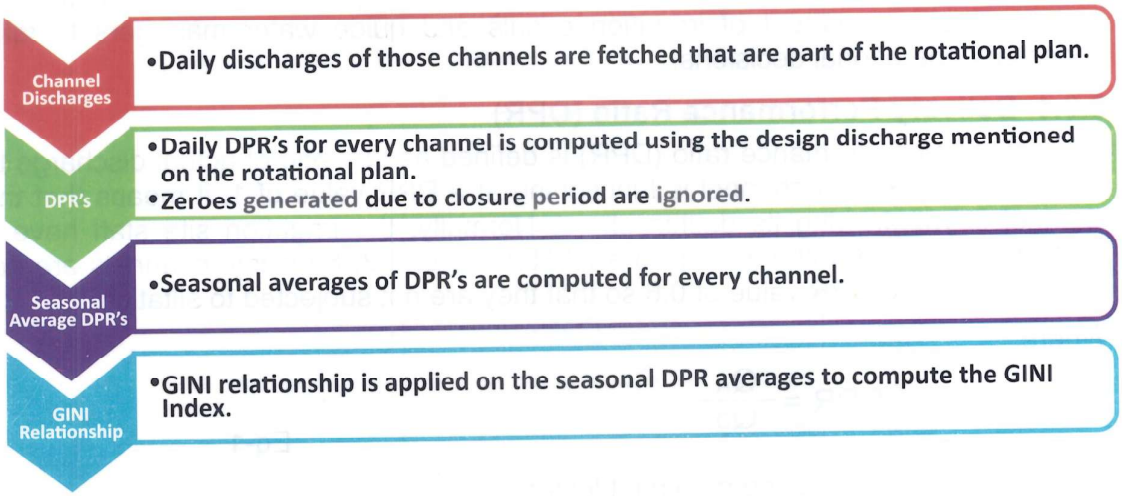

Figure-3: Schematic for computing GINI Index

3.0.3 Plan Implementation Ratio

An in-house logic has been developed to estimate the percentage of plan implementation of the executed rotational plan during a season. The logic can be implemented on individual waras as well as for the complete season. This flexibility is provided to the user so that percentage of plan implementation could be tracked for desired time window.

The logic is a function of the daily discharges of the channels and compares them to compute the implementation percentage. The user is required to input the rotational plan and define two threshold values of DPR's i.e. Upper DPR threshold and Lower DPR threshold. Currently, value of 1.2 and 0.8 have been selected. Daily discharges of the channels, which are part of the rotational plan, are taken from Irrigation Department database against the dates during which the analysis is intended. These dates can be for the complete season or any particular waras. Fetched discharges are arranged in a row wise pattern against the dates and follows the preference order that is mentioned in the rotational plan. Their corresponding daily DPR's are computed and arranged in the similar way. Once DPR values are properly ordered, maximum DPR value of each group is identified and placed against the dates in the similar row wise fashion.

It is to be noted that maximum DPR of the least priority group is of no interest for logic implementation and therefore ignored. After the processing of data, DPR of every channel is compared with the user defined thresholds and the maximum DPR of the consecutive group. Based on the comparison, the developed logic could either be true or false. This activity is continued till the intended last date of the analysis. In the end, the total instances of TRUE and FALSE decision occurrences are counted for calculating the plan implementation percentage. It is to be mentioned that the above logic is applied for all the channels on each day. The channels residing in the least priority groups, however, are not considered in the analysis and therefore

skipped. A schematic for computing the plan implementation percentage is shown in the Figure-4. During the closure period in Rabi season, plan implementation is computed by analyzing the head discharge of the parent channel. If the head discharge is null during the planned closure date, the conditions are counted as TRUE, as the channel has been closed according to the rotational plan, and vice versa.

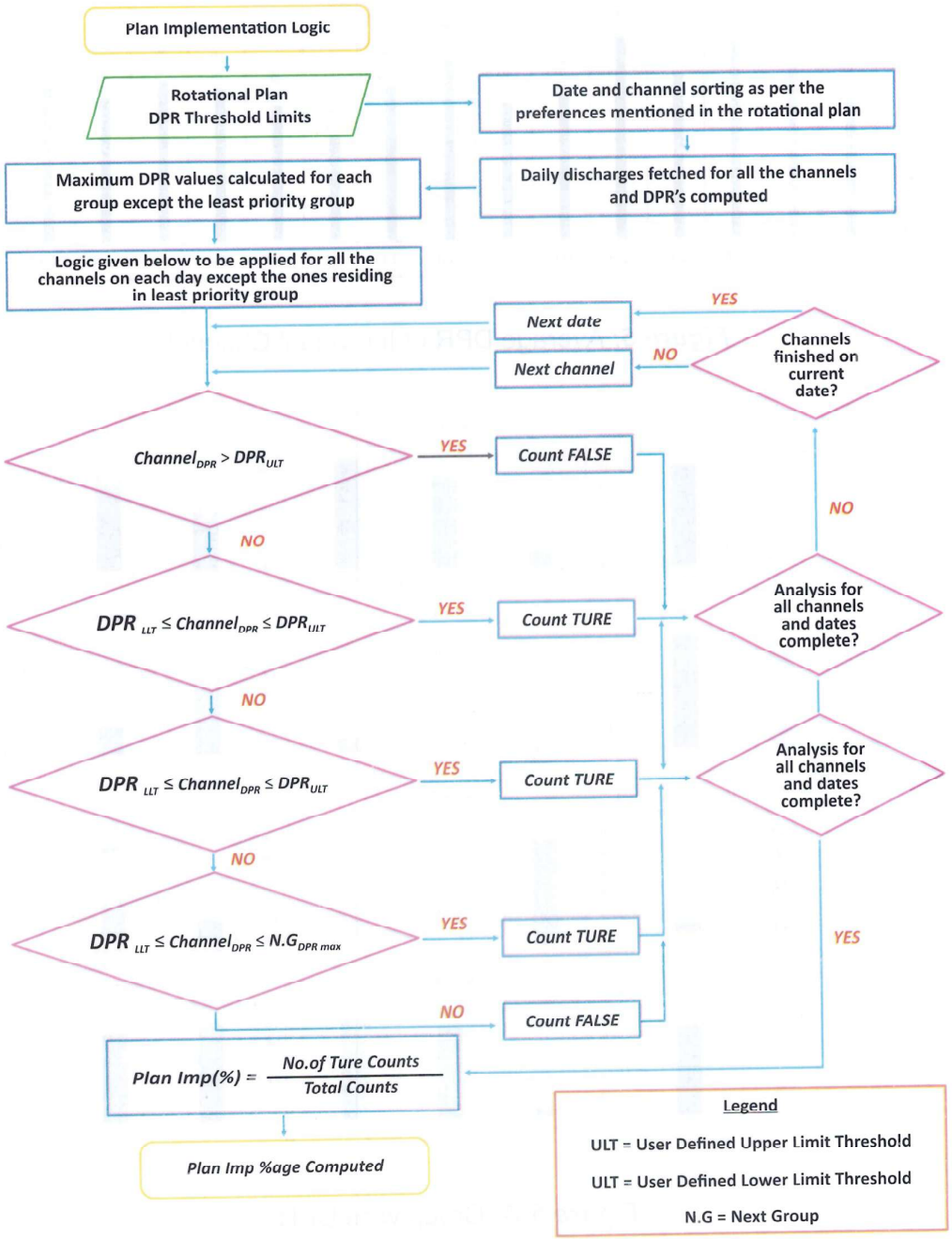

Figure-4: Schematic for computing plan implementation percentage

4.0 RESULTS AND DISCUSSION

Rotational Analysis tool for the Hakra Irrigation canal is developed. It can be seen from the figure that the rotational plan has been strictly followed. It can be seen that from the result in the week 22 only group-C is facilitated and rest of the group could not get their fair.

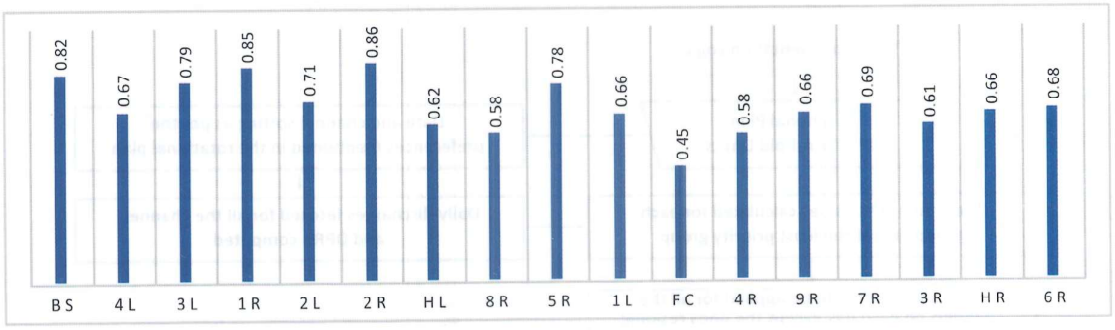

Figure-5: Average DPR of Individual Channel

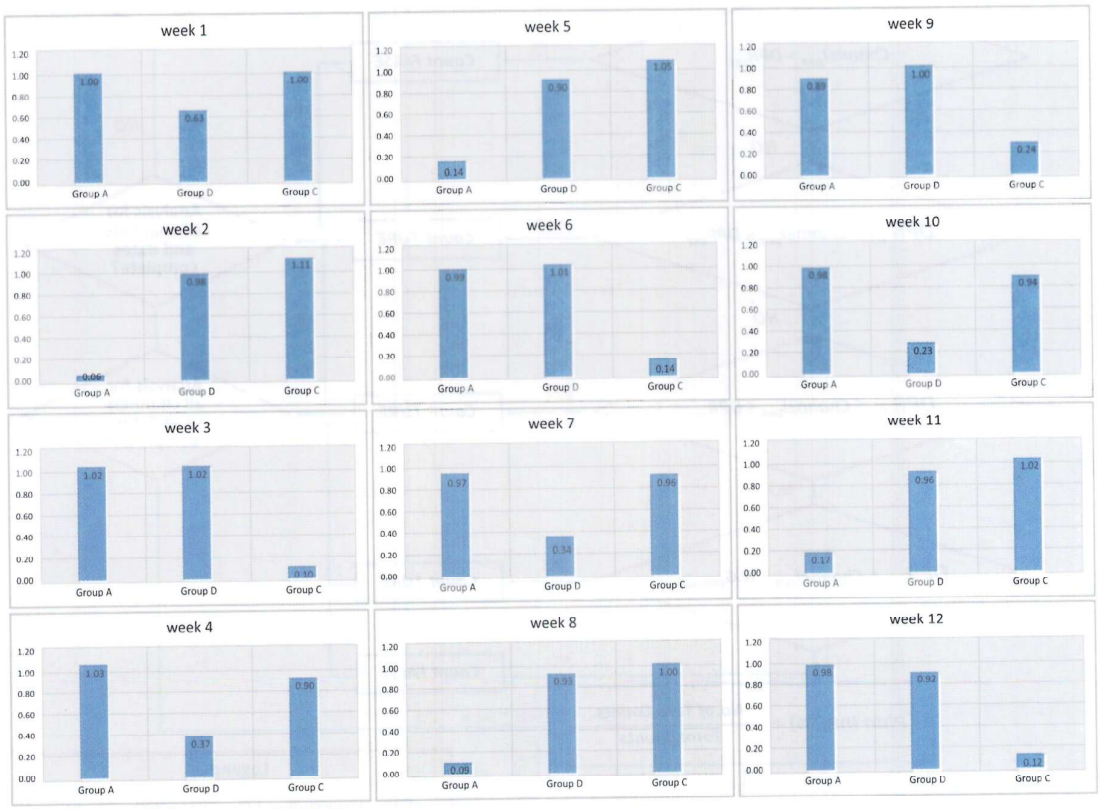

Figure-6-A: Group wise DPR

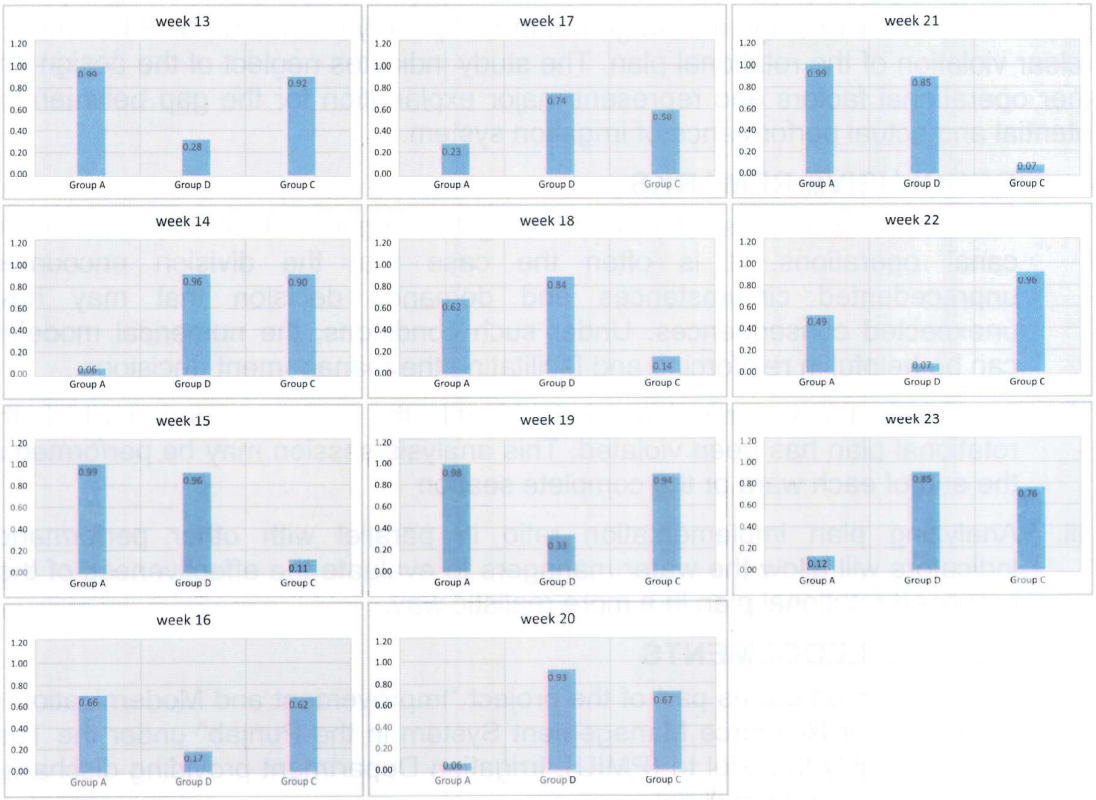

Figure-6-B: Group wise DPR

Table-3: Results Summary

Plan Implementation Statistics		Equity (GINI)
Total Checks	920	Overall GINI= 92%
True Checks	528	
False Checks	392	
Impl. Ratio logic _0	57%	Group A=97%
Impl. Ratio logic _1	82%	Group B=90%
Impl. Ratio logic _2	84%	Group C=99%

Rotational Plan is prepared at division level on seasonal basis (Rabi and Kharif) for Hakra canal division. In the rotational plan the 1st priority canals run on their design discharge with (±10% variation of the design discharge which is depicted in the results. Similarly, 2nd and 3rd priority channels in the rotational plan run as per water availability in the parent channel It can be seen from Table-3 that plan implementation percentage and GINI index are in direct relationship, however, it does not necessarily have to be directly proportional. it can be seen from Figure 6-A and Figure 6-B that among three groups, one group of the channels for rotational plan possess an average DPR greater than 80%. The average DPR as mentioned in the figure-5 vary from 0.45 to 0.86 means inequitable distribution among the canals but in the Group Wise it shows that the distribution among the group is

equitable. It was also observed that DPR in week 8 (Wara 8) the canal at 2nd priority run as 100% of their design discharge but the 1st priority canals run as 93% which is a clear violation of the rotational plan. The study indicates neglect of the design and other operational factors and represent major explanation for the gap between the potential and actual performance of irrigation system.

4. CONCLUSIVE REMARKS

i. This tool can also assist in forecasting the impacts of decisions related to canal operations. It is often the case that the division encounters unprecedented circumstances and demands decision that may have unexpected consequences. Under such conditions, the numerical modeling can be helpful in reinforcing and facilitating the management decisions.

ii. It will help the water managers to identify the instances during which the rotational plan has been violated. This analysis session may be performed at the end of each wara or the complete season

iii. Analyzing plan implementation ratio in parallel with other performance indicators will allow the water managers to evaluate the effectiveness of their proposed rotational plan in a more realistic way.

5. ACKNOWLEDGEMENTS

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