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CONTENTS

Research Papers

AGING: CAPTURING VICISSITUDES OF PHONOLOGY

Girija PC[1], Nayana N[2] and Suparna R[3]
[1,2]Department of Audiology and Speech Language Pathology, AWH Special College, Calicut
[3]Department of Audiology and Speech Language Pathology, BMH, Calicut

ABSTRACT

Need: impact of aging in language is a relatively new area with sparse substantial studies specific to phonology which is the basic form of language

Aim: to investigate the impact of aging on phonology through word and non word repetition task in successive bilinguals

Method: 150 bilingual adults with age range of 30 and 80 years, sub grouped into 31-40years, 41-50years, 51-60years, 61-70years and 71-80years, were subjected to word and non word repetition task in their first and second language (Malayalam and English).

Results: Overall analysis revealed that subject performed better in their first language for both the tasks. Number of participants committing errors increased with age with more errors at greater syllabic length. Better performance was observed for repetition of words in both the language as compared to repetition of non-words. Most of the participants in older age groups committed omissions and segmentation errors followed by increased duration of latency. Substitution errors were negligible for both categories in either of the languages and transposition showed no evident trend.

Conclusion: Aging creates difficulty in independent functioning of phonological working memory which has active involvement in production and processing of non-words where as repetition of words exploits both phonological working memory as well as semantic memory.

Keywords: Aging, Phonology, Bilingualism, Words, Non-words

1. BACKGROUND

Aging can be considered as a conventional phenomenon wherein an individual undergoes gradual deterioration in physical as well as mental processes. The degree and type of decline depends upon many factors like the individual's quality of life, education, physical health and related aspects etc.

Aging can create changes in higher mental processes which can eventually hamper communication abilities of an individual. Language is one of the many aspects which is compromised in geriatrics. For efficient communication, all the aspects of language including phonology, morphology, syntax, semantics and pragmatics needs to be intact. Any alteration or deterioration in any one these components can render substantial handicap for the elderly. Even though degradation in language as a whole is researched widely in aging population, specific analysis pertaining to each component is still a grey area.

Phonology is considered as an elemental unit in language. Even subtle permutations in phonology can impact the overall language thereby impeding effectiveness of communication. Burke & Shafto [3] reported an effective decline in form of language evident while retrieving spelling of familiar words. Similarly, MacKay & James [12] claimed that older adults exhibited increased number of phonological and morphological errors as compared to younger adults.

It can be considered that bilingual brain is less vulnerable to decline in normal aging in comparison with monolinguals. (Bialystok, Fergus, Klein, & Viswanathan,[2]; Gold, Johnson, & Powell [6]; Gold, Kim, Johnson, Kryscio and Smith [7]). Nevertheless, there might be subtle but substantial deteriorations in language which reflects especially in its form (phonology & morphology). It is highly essential to investigate these declines in phonological processing and production skills, as the age advances.

Word and non-word repetition tasks can be used for this purpose. Repetition is the action of repeating something that has already been said or written. It is the recurrence of an action or event. It requires active participation of left insular cortex, ventral pre motor region, and the striatum. Age related changes can have effect on repetition which can have impact on language performance. Since repetition of words calls for perception, storage and retrieval of its phonological constituents in a sequence, it is as a potential task to identify individuals with deficits in phonological working memory. Gathercole and Baddeley [4] and Gathercole, Emslie, Willis and Baddeley [5] suggested that non-word repetition allows a purer measure of short-term memory abilities than classical memory span tasks (i.e., digit span and word span).The non-word

repetition task invokes many of phonological short term memory processes such as storage, processing and retrieval (Gathercole & Bladdeley [4]; Henry & Millar [10]. Hence, It can be stated that word repetition task might be used as a supplemental task that is free from cultural biases and more sensitive in detecting the phonological aspects of word learning deficits.

2. AIM
To investigate the impact of aging on phonology through repetition of word and non words in Malayalam and English.

3. METHOD
3.1. Subject Selection
A total of one hundred and fifty right handed Malayalam- English successive bilingual adults with minimum education of 10th Standard and chronological age range from thirty to eighty years participated in the study. They were sub grouped into five, with thirty adults in each age group (31-40years, 41-50years, 51-60years, 61-70years and 71-80years). The subjects were screened for psychological, neurological, sensory, motor and Speech-Language deficits.

3.2. Material
A total of 150 words and 150 non-words were chosen in both the languages. Words in Malayalam were selected based on speaking vocabulary of adults, in the increasing order of syllable length from two to six syllables. Malayalam non-words were generated using the sounds within the phonetic inventory of the participants, by following the phonotactic rules of the language and by maintaining consonants of the original word. The non words constructed were such that none of their individual syllable (CV or CVC) corresponded to Malayalam word. This was done to ensure that non words included were not affected by subject's vocabulary knowledge. Each non word in Malayalam possessed single transposed sound or syllable. For exarmple, /Pena/ (bisyllabic word) /nepa/ (bisyllabic non-word); /padala/ (trisyllabic word) to /ladapa/ (trisyllabic non word); /varuma:nam/ (tetrasyllabiic word) to /vama:runam/ (tetrasyllabic nonword) etc.

The Malayalam words and non words prepared were subjected to a judgment on word likeliness on a four point rating scale by five qualified Speech Language Pathologists, by denoting '3' shows the highest degree (100%) of word likeliness and '0' shows the least degree (not at all similar to any of the meaningful Malayalam word) of word likeliness. The words which were rated with a point of '0' or '1' were included in the final list of non words, five at each of the two syllable length, three syllable length, four syllable length, five syllable length and six syllable length.

The list of English words and non words was adopted from the British Journal of Learning Disabilities. i.e. a set of five words and non words at two syllable length, three syllable length, four syllable length, five syllable length and six syllable length respectively.

The final list of non words (test items) were then audio recorded from a recording studio by a female native speaker of Malayalam, and the responses were audio recorded using Samsung recorder and saved in the PC.

3.3. Test administration
The words in Malayalam followed by the non words and then the English words and followed by the non words were presented through the headphones and their responses were audio recorded. The total time taken to complete the repetition task was twenty minutes.

3.4. Error analysis
Five categories of errors were considered, which were Substitutions, Omissions, Transposition, Duration of segmentation and Latency. The errors were identified through pilot study conducted on ten participants from each age group specified in our study.

3.5. Data analysis
The non words and words were analyzed for overall accuracy, accuracy at different syllable lengths and type of errors. Test-retest reliability was established for 50% of the subjects selected for the study from each group.

Overall accuracy was calculated by tabulating total number of words repeated correctly. Accuracy at different syllable length was calculated by comparing the target non word and word with the repeated utterance. The exact repetition yielded a score of '0' where as error including Substitutions, Omissions, Transposition and Latency was scored as '1'. The scoring for duration of segmentation was given as: 0-2 sec = of 0; 2-3 sec = 1 and 3-4 sec = 2.

3.6. Statistical analysis
The obtained data from all the age groups was approximately tabulated and subjected to statistical measures. SPSS software (version 17) packages were used for statistical analysis. Descriptive statistics was used to compute the mean and standard deviation.

4. RESULTS
Table 1 represents error analysis of Malayalam words across the age group. Our results indicated that in general, none of the participants committed errors for repetition of Malayalam words, except one in the age range of 71-80 years, who exhibited omission at the sixth syllable level.

Table-1: Error analysis of Malayalam word repetition across the age groups

Error	Age	Present	Absent	Syllable length				
				2	3	4	5	6
Substitution	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	0	30	-	-	-	-	-
Omission	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	1	29	-	-	-	-	1
Segmentation	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	0	30	-	-	-	-	-
Transposition	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	0	30	-	-	-	-	-
Latency	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	0	30	-	-	-	-	-

Note. Present/absent indicates the occurrence and non-occurrence of errors across the age group respectively. "- " represents the absence of errors whereas "1" indicates that one participant had omission error at sixth-syllable level.

Table 2 represents error analysis of Malayalam non word repetition across the age group. Two participants in age group of 61-70 and 71-80 were eliminated as they were unable to complete the required tasks. None of the participants in the age group of 31-40 years committed any error. In the age range of 41-50 years out of thirty participants, three participants exhibited omission errors and four participants exhibited segmentation errors at 6th syllable. Furthermore, among them one participant committed both these errors at 5th syllable level. All the error types except transposition were identified in the age range of 51-60 years. One participant showed substitution error and increased latency at 6th syllable level. Segmentation errors were manifested in seven participants at 6th syllable and one participant at 5th syllable level. Eight participants presented omissions at 6th syllable and among them five exhibited the error at 5th syllable level. Results obtained for the age range of 61-70 years indicate that substitution errors were nil whereas five participants showed omission errors at 5th syllable level and eighteen participants showed the error at 6th syllable level. Likewise, segmentation errors started at 4th syllable level for a single participant. This increased to four participants at 5th syllable level and six participants at 6th syllable level. Transposition was only observed in a single participant, which was at 4th syllable level. Increased latency was shown by total of four participants at 6th syllable level, out of which a single participant demonstrated the error even at 5th syllable level. In the uppermost age range, total of five participants demonstrated substitution errors at 6th syllable level, omissions were observed for two participants

at 4th syllable, eleven participants at 5th syllable which tremendously increased to 20 participants at 6th syllable. Segmentations were seen for a sole participant at 4th syllable level, eight participants at 5th syllable level and peaked to fourteen participants at 6th syllable level. No transposition errors were noted in any of the participants. However, increased duration of latency was present for three participants at 5th syllable level and six participants at 6th syllable level.

Table-2: Error analysis of Malayalam non word repetition across the age groups

Error	Age	Present	Absent	Syllable length				
				2	3	4	5	6
Substitution	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	1	29	-	-	-	-	1
	61-70	0	28	-	-	-	-	-
	71-80	5	23	-	-	-	-	5
Omission	31-40	0	30	-	-	-	-	-
	41-50	3	27	-	-	-	1	3
	51-60	8	22	-	-	-	5	8
	61-70	18	10	-	-	-	5	18
	71-80	20	8	-	-	2	11	20
Segmentation	31-40	0	30	-	-	-	-	-
	41-50	4	26	-	-	-	1	4
	51-60	7	23	-	-	-	1	7
	61-70	6	22	-	-	1	4	6
	71-80	14	14	-	-	1	8	14
Transposition	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	1	27	-	-	1	-	-
	71-80	0	28	-	-	-	-	-
Latency	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	1	29	-	-	-	-	1
	61-70	4	24	-	-	-	1	4
	71-80	6	22	-	-	-	3	6

Note. Present/absent indicates the occurrence and non-occurrence of errors across the age group respectively. '-'represents the absence of errors and numerical values of each cell depicts the number of participants who committed that particular error. Two participants were eliminated in the age group of 61-70 and 71-80 years due to inability to complete the task.

Table 3 portrays error analysis of English word repetition across the age group. None of the participants had any error in the lowermost age range of 31-40 years. In the following age group, that is 41-50 years and 51-60 years, participants exhibited only omissions at 5th syllable level (one participant in each group) and 6th syllable (three participants in 41-50 years and five participants in 51-60 years). In the age range of 61-70 years, once again no participants produced substitution errors. Howbeit, omission errors were noticed for five participants at 5th syllable level and ten participants at 6th syllable level. Transposition and increased duration of latency were committed exclusively by one participant at 6th syllable level. In the apical age group of 71-80 years, substitution errors were reported in one participant at 4th syllable level, two participants at 5th syllable level and three participants at 6th syllable level. Omissions were seen in five participants at 4th syllable level, seven participants at 5th syllable level and ten participants at 6th syllable level. Three participants at 5th syllable level and seven participants at 6th syllable level showed segmentation errors. One participant showed transposition at 5th and 6th syllable level. Latency errors were seen in one participant at 5th syllable level and two participants at 6th syllable level.

Table-3: Error analysis of English word repetition across the age groups

Error	Age	Present	Absent	Syllable length				
				2	**3**	**4**	**5**	**6**
Substitution	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	0	30	-	-	-	-	-
	71-80	3	26	-	-	1	2	3
Omission	31-40	0	30	-	-	-	-	-
	41-50	3	27	-	-	-	1	3
	51-60	5	25	-	-	-	1	5
	61-70	10	20	-	-	-	5	10
	71-80	10	20	-	-	5	7	10
Segmentation	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	4	26	-	-	-	2	4
	71-80	7	22	-	-	-	3	7
Transposition	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	1	29	-	-	-	-	1
	71-80	1	28	-	-	-	1	1
Latency	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	0	30	-	-	-	-	-
	61-70	1	29	-	-	-	-	1
	71-80	3	26	-	-	-	1	2

Note. Present/absent indicates the occurrence and non-occurrence of errors across the age group respectively. '-'represents the absence of errors and numerical values of each cell depicts the number of participants who committed that particular error. One participant was eliminated in the age group of 71-80 years due to inability to complete the task

Table 4 outlines error analysis in English non words. Participants in the age range of 31-40 years had none of the errors. Two participants in age range of 41-50 years showed omission error at 5th syllable whereas six participants committed the same error at 6th syllable. Segmentation errors were spotted in one participant at 5th syllable level and five participants at 6th syllable level. Transposition was observed only in one participant at 4th syllable level. Increased latency was reported only in one participant at 6th syllable level. In the subsequent age group of 51-60 years, 61-70 years and 71-80 years, substitution errors were recorded in one participant in each age group at 5th syllable level, two and three participants respectively at 6th syllable level. Omission errors were reported for two participants at 5th syllable level and six participants at 6th syllable level in 51-60 years whereas in the higher age group, i.e. 61-70 years and 71-80 years omissions increased, from one to six participants at 4th syllable level, from seven to ten participants in 5th syllable level and from nineteen to twenty participants at 6th syllable level. Segmentation errors were exhibited by one participant at 5th syllable and five participants at 6th syllable in the age group of 51-60 years. No transposition errors were reported in the same age group. However, one participant in the group presented with increased duration of latency in 6th syllable. Six participants in the age of 61-70 years rendered segmentation errors at 5th syllable level and twelve participants rendered the same at 6th syllable level. Transposition was expressed by one participant at 4th syllable. Increased duration of latency was accounted in six participants at 5th syllable and eight participants at 6th syllable level. No transposition errors were identified in the age group of 71-80 years. Although segmentation error increased from two participants at 4th syllable level to thirteen participants at 5th syllable level eventually to twenty three participants at 6th syllable level. Increased latency duration were reported in two participants at 4th syllable, thirteen each at 5th and 6th syllable level.

Table-4: Error analysis of English non word repetition across the age groups

Error	Age	Present	Absent	Syllable length				
				2	3	4	5	6
Substitution	31-40	0	30	-	-	-	-	-
	41-50	0	30	-	-	-	-	-
	51-60	3	27	-	-	-	1	2
	61-70	4	26	-	-	-	1	2
	71-80	4	24	-	-	-	1	3
Omission	31-40	0	30	-	-	-	-	-
	41-50	6	24	-	-	-	2	6
	51-60	7	23	-	-	-	2	7
	61-70	19	9	-	-	1	7	19
	71-80	20	10	-	-	6	10	20s
Segmentation	31-40	0	30	-	-	-	-	-
	41-50	5	25	-	-	-	1	5
	51-60	10	20	-	-	1	4	10
	61-70	12	18	-	-	-	6	12
	71-80	23	5	-	-	2	13	23
Transposition	31-40	0	30	-	-	-	-	-
	41-50	1	29	-	-	1	-	-
	51-60	0	30	-	-	-	-	-
	61-70	1	27	-	-	1	-	-
	71-80	0	28	-	-	-	-	-
Latency	31-40	0	30	-	-	-	-	-
	41-50	1	29	-	-	-	-	1
	51-60	1	29	-	-	-	-	1
	61-70	8	22	-	-	-	6	8
	71-80	13	15	-	-	2	13	13

Note. Present/absent indicates the occurrence and non-occurrence of errors across the age group respectively. '-'represents the absence of errors and numerical values of each cell depicts the number of participants who committed that particular error. Two participants were eliminated in the age group of 71-80 years due to inability to complete the task.

5. DISCUSSION

After carrying out the pilot study we could detect the major errors present during the repetition of Malayalam and English words and non-words. The error type undertaken by us included substitution, omission, segmentation, transposition and duration of latency. From the results we could gather that all of these errors had individual progressive trend with respect to advancing age. Hence for a comprehensive understanding, it is mandatory to discuss each error in details in the scenario of each task.

5.1. Age and word repetition

Figure 1 represents number of participants exhibiting individual error with advancing age during repetition of Malayalam words. From the figure we can derive that in the first language that is Malayalam, the only error detected is omission in the uppermost age range (71-80 years) for this task. Only one participant committed the error, thereby suggesting that there exist no effect of aging on repetition of Malayalam words. As inferred from table 1, there was no significant effect of age progression on syllable length, bar one participant from 71-80 years for omission. The reasons for this could be due to the word familiarity and frequency effect, as the words selected for our study even at the 6th syllable level, were relatively often occurring during daily communication. The high exposure to these words would increase the probability in them being transferred to semantic long term memory, which further improves the imageability and concreteness of these words. These results reflect the constancy of semantic long term memory with advancing age which dominates over all other cognitive faculties thereby balancing age related progressions of errors for Malayalam word repetition. Zacks, Hasher, & Li, [23] reported analogous findings while reviewing studies relating memory and age. Concurrently, Levine, Svoboda, Hay, Winocur and Moscovitch [11] reported that there exists dissociation between semantic and episodic memory of older individuals where in semantic long term memory shows better perseverance.
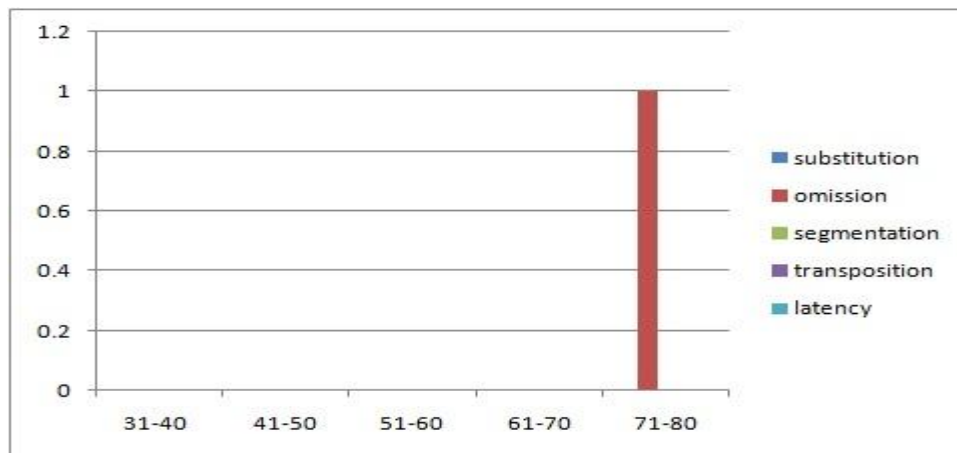
Figure-1: Participants exhibiting individual error with advancing age during repetition of Malayalam words

For English words all the errors showed a progressive trend as age increases, with maximum errors being omission, followed by segmentation then Latency and substitution, and finally transposition as evident from figure 2. Compared to English (second language) Malayalam is more automatized as it is the native language of our participants and hence subjected to frequent exposure. This would render more cognitive load for repetition of English words as it involved phonemic transfer from first language L1 to second language L2. In older subjects there is missing of information even at phonological level due to incapacitated working memory which led to more omissions. Verhoeven's [22] report on successive bilinguals suported our result by demonstrating transfer of information from L1 to L2 for development of phonotactic awareness and phonemic awareness of subjects. Concurrently, Sun-Alperin and Wang [20] accounted an increased phonemic deletion in English language L2 for Spanish – English bilinguals during reading and spelling tasks. This reflected a straightforward phonemic transfer from L1 Spanish to their L2 English during orthographic as well as phonological processing.
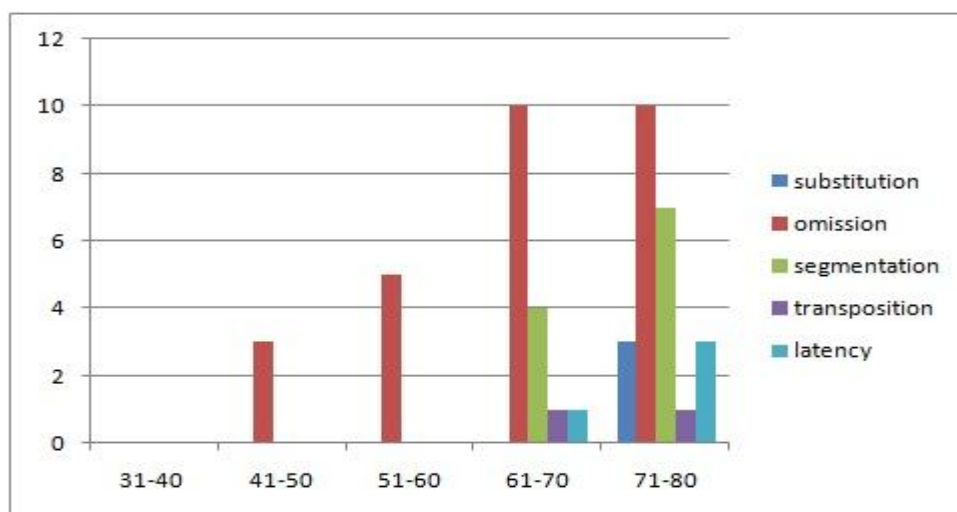
Figure-2: Participants exhibiting individual error with advancing age during repetition of English words

The increased incidence of segmentation errors lay on the difference between phonemic boundaries of Malayalam and English. The phonotactic abilities of Malayalam differs from English thereby distinguishing the phonemic boundaries of both the languages. The rules for processing are different for both the languages. However our subject being successive bilinguals had the tendency to place phonotactic restrictions as well as phonological alternations on L2 words according to L1 rules. Following optimality theory by Prince and Smolensky [16] one can derive that both phonotactic restrictions as well as phonological alternations based on a single set of constrains which are positioned under the long term memory . Also adding onto this fact, that the L2 learning generates novel rules which are imbibed on short term memory. As short term memory is depleted with age together with increased long term memory usage, the tendency to process L2 based on L1 resulting in greater segmentation errors. Papagno and Vallar [15] reported that word length disrupted the repetition of novel words. This support our results suggesting that novel words of L2 generates more error which increases proportionally with syllable length. Substantiating this is the findings of Grivol and Hage [8] who summarized that score for phonological working memory tasks were impoverished in the elderly suggesting that this ability declines with the aging process

Increased latency errors can be explained as a consequence of loss of neuron and myelination. This would increase the duration of latencies as age progresses (Berlet & Volk, [1]; Meier-Ruge, Ulrich, Bruhlman, Meier [14]; Marner, Nyengaard, Tang & Pakkenberg, [13]) Decreased rate of encoding and activation of information also contributed to slowing of latencies. Similar finding was reported by Salthouse [18].

Substitution and transposition errors were negligible compared to other errors. Active participation of long term memory for word recognition could be the reason for this result.

5.2. Age and non-word repetition

Figure 3 delineate the progression of error for Malayalam non-words with advancement of age. Overall analysis reveal that errors as a whole increases as age advances. However, increment of each error type varies. The most significant progression was noted for the error omission followed by segmentation and duration of latency. Substitution errors did not show significant increment with advancement of age and transposition error showed no specific trend. Table 2 points out that there exist a direct proportionality between age advancement and syllable length with participants in upper age group exhibiting more errors at 5th and 6th syllable in comparison to 2nd, 3rd and 4th syllable. Figure 4 and Table 4 summarize the effect of aging on English non-word repetition. The values imply that segmentation errors dominated over other error types followed by omission and latency, with aging. Substitution and transpositions once again showed negligible increment. Here also there was a strong influence of syllable length.
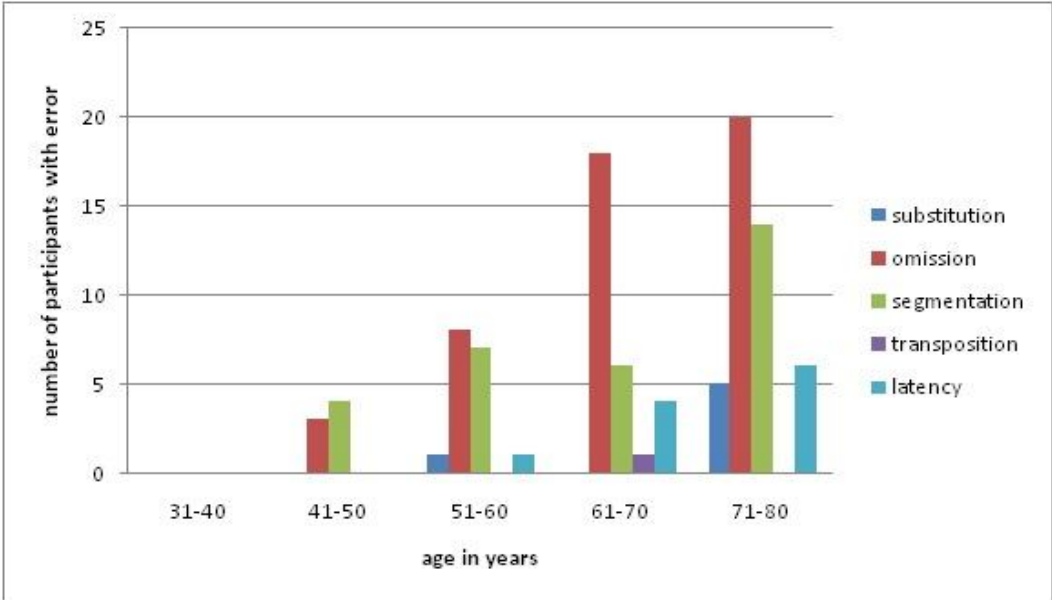
Figure-3: Participants exhibiting individual error with advancing age during repetition of Malayalam non words
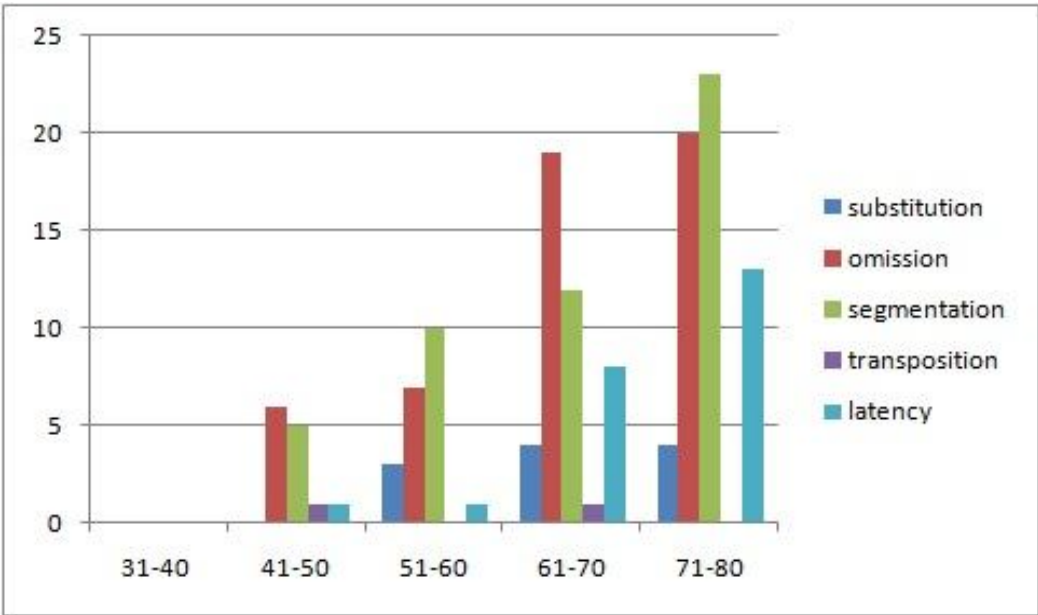
Figure-3: Participants exhibiting individual error with advancing age during repetition of English non words

The poor performance on non word repetition task could be because, as age increases the phonotactic probability of the individual decreases thereby exerting more loads on activation of phonological working memory. For accomplishment of repetition of non words it is necessary to have proper connection and interaction between the perceptive analysis system and the phonological planning. The perceptive analysis system provides imitation which helps in the generation of sequence of phonemes which are not frequently present in the lexicon. Non words involved speech perception, decomposition and parsing of the speech stream into phonological units, rehearsal in phonological working memory, reassembly of the phonological units into an articulatory program and speech production which becomes more and more tedious as the age advances thereby tapering their performance for the repetition of the same. Age associated neurobiological changes mainly in prefrontal cortex and subcortical structures with variations in regional cerebral blood flow can curtail the rate, range and co-ordination of articulatory movements. The rate of speech and articulatory movements do not co-ordinate as age increases. Hence, to compensate for the lost time the older individuals tends to omit certain phonemes which become more pronounced with increased syllable length.

The task involved here is repetition of non-words. Each subject was tasked to listen to the non-word, store them in working memory for a brief time and repeat them back. Except for working memory there was no involvement of other cognitive faculties. Therefore the subject would have adopted different strategies including chunking for storing the targets in working memory. Shea, Park & Braden [19] reported that older individuals fail to follow a clear chunking pattern during sequence learning. Further, the age related slowing of processing may affect the central timing mechanism (Rakitin and Malapani [17]; Vanneste, Pouthas & Wearden[21]). This could lead to slower processing of individual chunks which resulted in the target being segmented more frequently. These facts explained the increased occurrence of segmentation errors with aging. Our results have shown that progression of these segmentation errors are more in English, as the phonotactics of Malayalam and English are different. Malayalam has fewer vowels and consonants, and many words have CVCV patterns. This makes it easier to chunk and store the longer non- words of Malayalam in phonological working memory as compared to English. The subjects required extra chunks as well as more phonological rehearsals for English non-words. Also, the added factor of automaticity of first language (Malayalam) contributed to its faster chunking.

Duration of latency i.e. time required by the participant to repeat the target also increased with age. As age advances, there is loss of myelin sheath as well as reduction in neuronal density especially in pre-frontal areas. This led to lengthening of transmission time subsequently increasing the latency of response.

The substitution errors were negligible in both the languages for non-words. As all the participants were neurotypical individuals, they had active feedback system as well as competent judgments, which negated the possibility of them committing substitution errors.

Transposition errors did not show any significant trend. One participant in the age range of 61-70 years committed transposition at 4th syllable level. However, none of the participants in the higher age range committed the same error. Furthermore, the same participant did not commit transposition in 5th and 6th syllable level. Hence, the error at 4th syllable can be neglected as outlayer. Since non-words were unfamiliar to our participants, they had the tendency to process the word with syllables as basic unit. This tendency in combination with the impeded working memory capacity led to their attention to each syllable. That is, our participants processed each syllables of the word rather than the word as a whole thereby reducing word order errors.

6. CONCLUSION

Our study attempted to describe the Impact of aging on phonology was evaluated using word and non-word repetition in successive bilinguals for first language Malayalam and second language English. The results revealed that overall errors increased as age advances for both words and non-words. Greater errors were observed in second language compared to first language for both the categories. Syllable length directly correlated with the number of errors and non-words quantitatively demonstrated more errors. The higher the number of syllables of the non-words, more difficult was the sub vocal process of the working memory to rescue the verbal information declining and keep verbal material in memory Omission and segmentations were the predominant type of error followed by duration of latency. Substitutions showed negligible error and transpositions did not show any evident trend. The poor performance of older adults can be attributed to the effect of phonological working memory decline as age advances. The longer stimuli would tax the storage and rehearsal functions of the loop very much, which would lead to less complete and precise short- term representations and further less accurate repetitions of novel phonological forms. In nutshell, we can conclude that omissions and segmentation would serve as identifying features of phonology in neurotypical aging brain.

7. CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

8. ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

9. INFORMED CONSENT

Informed consent was obtained from all individual participants included in the study.

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AN INSIGHT INTO LIQUIDITY MANAGEMENT OF MFIS IN INDIA

Bhaskar Bagchi

Department of Commerce, University of Gour Banga, West Bengal

ABSTRACT

This examination looks at the connection among liquidity and profitability and furthermore the effect of liquidity on profitability of the Indian Microfinance Institutions. The information utilized in the present investigation are the liquidity and productivity the board markers of two driving Microfinance organizations (MFIs) which are acquired from the Center for Monitoring Indian Economy (CMIE) database. Current ratio, super quick ratio, debt-equity ratio, current assets to total assets and operational self-sufficiency are taken as explanatory variables while return on investment is taken as explained variable. The time frame covers 14 years commencing from April 1, 2004 to March 31, 2018. Throughout examination, clear measurements and trial of typicality, connection investigation and direct numerous relapses has been planned. Our examination results uncover that there exists negative connection between segments of liquidity and profitability. The outcomes additionally mean that there was a probability of various MFIs the board approach in bizarre stages.

Keywords: Liquidity, Profitability, Microfinance Institutions, Multiple Regression.

I. INTRODUCTION

Microfinance Institutions have been required to lessen destitution, which is considered as the most critical advancement objective (World Bank, 2000). Robinson characterizes Microfinance as little scale monetary administrations for the two attributes and stores that are given to individuals who ranch or fish or crowd; work little or miniaturized scale endeavors where merchandise are delivered, reused, fixed or exchanged; give administrations; work for wages or commissions; gain pay from leasing little measures of land, vehicles, draft creatures, or hardware and devices; and to different people and nearby gatherings in creating nations, in both provincial and urban regions (Robinson, 2001). The Task Force on Supportive Policy and Regulatory Framework for Microfinance established by National Bank for Agricultural and Rural Development (NABARD) characterized microfinance as the arrangement of saving, sparing, credit and monetary administrations and results of little add up to the poor in rustic, semi-urban and urban regions for empowering them to raise their pay levels and improve their way of life. (Sen, 2008). In numerous studies done across the world, it is generally believed that various microfinance initiatives have been able to make a difference in the lives of target beneficiaries. Nevertheless, expanding questions have been raised over the budgetary supportability of microfinance foundations.

MFIs should be monetarily feasible and supportable over the long haul yet monetary ramifications of long haul maintainability are not being considered (Srinivasan et al., 2006). At least in India, there does not seem to be any working model of analyzing the liquidity management and thereby sustainability of microfinance institutions. This issue is aggravated by the nonappearance of a devoted enactment on working and the board of microfinance establishments. The absence of an administrative system for budgetary exposures by microfinance establishments likewise abets the issue.

Liquidity plays a significant role in the successful functioning of a MFI. The MFI should ensure that it does not suffer from lack-of or excess liquidity to meet its short-term compulsions. An investigation of liquidity is of real significance to both the inward and the outer investigators as a result of its cozy association with everyday tasks of a business (Bhunia, 2010). Dilemma in liquidity management is to achieve desired tradeoff between liquidity and profitability (Raheman et all, 2007). Alluding to hypothesis of hazard and return, speculation with more hazards will result to more return. Thus, MFIs with high liquidity of working capital may a have low risk and low profitability. Conversely, the MFIs that has low liquidity of working capital, facing high risk resulting to high profitability. The issue here is in overseeing working capital, firm should mull over every one of the things in the two records and endeavor to adjust the hazard and return (Lee et. al 2008).

Microfinance institutions (MFIs) are now being confronted with the challenge of sustainability and outreach. These challenges were surveyed by Baland et. al (2019); Panda (2018); Chen et. al (2017); Satpathy (2017); Viswanathan et. al (2017); Haldar & Stiglitz (2016); Agarwal & Sinha (2010); Crombrugghe et. al. (2007); Singh (2011); Tulchin et. al. (2009); Bi, & Pandey (2011) and Tucker & Miles (2006). They found that three important aspects of sustainability such as repayment of loans, financial self sustainability or operational self sustainability and cost-control or efficient use of resources in analyzing performance for a sample of MFIs in

India and the sustainability of microfinance institutions is more important in order to pursue their objectives through good financial performance.

Consequently, this study is an attempt to analyze the liquidity management of leading (because of its high-potential capacity for rapid growth and visionary and strong leadership) microfinance institutions operating in India. It assumes significance, because it is imperative that these institutions be run efficiently given the fact that they are the users of marginal and scarce capital and the intended beneficiaries are the marginalized sections of society. MFIs must be able to sustain themselves financially in order to continue pursuing their lofty objectives, through good liquidity management.

II. REVIEW OF LITERATURE

Though, there are large numbers of literatures available on the performance of MFIs across the globe, only few studies have been carried out on the financial performance analysis and sustainability of Indian MFIs, which also focuses on the liquidity management to some extent. The essences of those literatures are presented hereunder.

Tucker, M. (2003), found out financial ratios of 17 Latin American MFIs which are then compared to benchmark performance ratios for the industry and with commercial Latin American banks.

Stephens, B. and Tazi, H. (2006), features the execution of the microfinance area in the South Asian locale just as internationally. The examination has featured South Asia for the investigation because of the district's amazing effort with microfinance monsters, for example, Grameen Bank, ASA and BRAC.

Tucker, M. and Miles, G. (2006), compares the performance of MFIs that have attained self-sufficiency with those that have not and comparing both to regional commercial banks in developing countries on selected financial ratios. The study reveals self-sufficient MFIs are strong performers on return on assets and return on equity.

Crombrugghe, A. D. et. al. (2007), has studied three important aspects of sustainability such as repayment of loans, financial self sustainability or operational self sustainability and cost-control or efficient use of resources in analyzing performance for a sample of MFIs in India.

Roy, M. and R. Øystein Strøm, (2009), inspects the connection between firm execution and corporate administration in microfinance establishments (MFI) utilizing a self-built worldwide dataset on MFIs gathered from outsider rating organizations.

Tulchin, D. et. al. (2009), have identified eight financial ratios for microfinance reporting and worked with those ratios.

Agarwal, P. K. and Sinha, S. K. (2010), found in their study that the sustainability of microfinance institutions is important in order to pursue their objectives through good financial performance.

Bi, Z. and Pandey, S. L. D. (2011), attempts to compare the financial performance of Indian microfinance institutions with that of commercial banks in India and also to analyze profitability and efficiency of MFIs in India.

Singh, P. K. (2011), have tried to understand the MFI rating model developed by CRISIL and takes both social impact and financial indicators into consideration in evaluating performance of Indian MFIs.

A. Research Gap

It is being disclosed from foregoing review of literature and experiments that no in-depth research work has been done on liquidity management of the Indian MFIs and thus reveals wide room for the validity and originates of this work and reflects some crucial clues that affirm its viability, as may be marked here it. Neither any study has incorporated the liquidity management of MFIs in India, nor has any previous research examined the relationship between liquidity, solvency and profitability.

B. Core Research Questions

To gain an insight and understand the relationship between liquidity management and profitability of two leading MFIs in India – Bharat Financial Inclusion Limited (formerly SKS Microfinance Limited) and Spandana Sphoorty Financial Limited (SSFL) over a period of 14 years (2004-05 to 2017-18), we seek answers to the following questions which are addressed below:

- What is the nature and extent of the relationship between liquidity, solvency and profitability?

- What is the impact of liquidity management indicators on profitability?

III. METHODOLOGY OF THE STUDY

In this section, we talk about the institutions and variables included in the study, the distribution patterns of data and applied statistical techniques in exploring the liquidity-profitability relationship.

A. Sample Planning and Period of the Study

The data used in the present study have been obtained from CMIE database. The purposive sample design method has been applied in this study. The sample is based on financial statements of two leading micro finance institutions of our economy, those who have often been neglected for enquiry and research. The definitions of 'leading' are: (i) high-potential capacity for rapid growth using the Unitus Acceleration Model: a) an immediate constraint to growth, b) a short-term constraint, c) a stable or perhaps a long-term constraint, or d) a strength that will fuel growth. (ii) "Visionary leadership", through identifying the characteristics, attributes and skills that are necessary to lead an MFI to sustainable growth and (iii) strong leadership (Bagchi, et. al., 2012).

Two leading MFIs in India were identified during the year of determination as the latest data for investigation were available from CMIE for these two MFIs only and thus due to controlled sample volume for MFIs, the research focuses only on the leading MFIs. For the purpose of analysis, a study period of 14 years (2004-2005 to 2017-18) has been covered. A brief profile of these MFIs is portrayed hereunder in table 1.

Table-I: Brief Profile of Selected Leading MFIs

Name of the MFIs	Gross Loan Portfolio (INR Crore)	Net worth (INR Crore)	Number of Active Borrowers (in 000)
Bharat Financial Inclusion Limited	12,594	2,999	5324
SSFL (Spandana Sphoorty Financial Limited)	3166	1675	1590

Source: Data accessed on 02 April 2019, from Co's Reports

B. Variables

In the course of analysis, core variables were identified that persuade not only liquidity-profitability relationship but also solvency and operational self-sufficiency of the MFIs as well. The ratios used are chosen from those utilized by Sa-Dhan (2005) and Singh, P. K. (2011) which is shown below in table 2.

Table-II: Selected Variables

Sl. No.	Independent Variables	Sl. No.	Dependent Variable
1.	Current Ratio (CR)		
2.	Super Quick Ratio (SQR)		
3.	Debt-Equity Ratio (DER)	1.	Return on Investment (ROI)
4.	Current asset to Total Asset (CATA)		
5.	Operational self-sufficiency (OSS)		

Source: Own Computation

C. Descriptive Statistics and Test of Normality

Descriptive statistics of the selected dependent and independent variables are portrayed in table 3 and table 4. All variables were calculated using accounting ratios. The accounting ratios were used because the CMIE database provides all ratios related to the variables, which was used in this study. In order to achieve the objectives of the study, five performance indicators/independent variables and one profitability indicator/dependent variable were tested by comparing with grand benchmark. The Jarque-Bera (JB) test of normality was done to find out whether the series was normally distributed. Selected variables of both MFIs show positive and negative skewness and the kurtosis indicates that all the selected variables were less peaked (platy-kurtic) than normal distribution because for a normal distribution, the skewness coefficient and kurtosis coefficient are 0 and 3 respectively. In that case, the value of the Jarque-Bera (JB) statistic is expected to be 0. In the event that the registered p estimation of the JB measurement in an application is adequately low, which will occur if the estimation of the measurement is altogether different from 0, one can dismiss the theory that the residuals are regularly appropriated. But if the p value is reasonably high, which will happen if the value of the statistic is close to 0, we do not reject the normality assumption (Gujarati, et. al., 2012). In our study, the JB statistic for all the variables confirms that none of the series were normally distributed, because the associated p values were sufficiently low.

Table-III: Descriptive Statistics of Bharat Financial Inclusion Limited

Variables	CR	SQR	DER	CATA	OSS	ROI
N	6	6	6	6	6	6
Maximum	5.55	5.20	9.51	0.99	122.09	25.15
Minimum	1.04	1.03	4.52	0.18	104.59	1.29
Mean	3.15	2.94	7.10	0.41	113.34	8.58
Benchmark	**2.57**	**1.54**	**5.69**	**0.25**	**100.00**	**5.98**
S.D.	1.94	1.87	2.31	0.32	6.59	8.42
Benchmark	**1.48**	**1.29**	**4.87**	**0.29**	**86.04**	**3.89**
C.V. (%)	61.59	63.60	32.54	78.05	5.81	98.14
Benchmark	**57.59**	**83.57**	**85.59**	**116.00**	**86.04**	**65.05**
Skewness	0.25	0.31	-0.04	1.70	-0.04	2.05
Kurtosis	-2.18	-2.40	-3.08	2.66	-1.41	1.74
J-B Statistic	0.23	0.25	0.03	0.98	0.02	1.14
Probability	0.01	0.00	0.00	0.02	0.00	0.00

Source: Own Computation

Table-IV: Descriptive Statistics of SSFL

Variables	CR	SQR	DER	CATA	OSS	ROI
N	6	6	6	6	6	6
Maximum	4.39	4.18	9.51	0.38	139.31	40.00
Minimum	1.33	1.03	4.52	0.15	105.58	6.76
Mean	3.12	2.63	7.10	0.24	129.07	22.66
Benchmark	**2.17**	**1.54**	**5.10**	**0.25**	**100.00**	**5.98**
S.D.	1.09	1.06	2.31	0.08	12.53	14.89
Benchmark	**0.18**	**0.01**	**0.45**	**0.29**	**81.57**	**3.89**
C.V. (%)	34.94	40.30	32.54	33.33	9.70	65.71
Benchmark	**57.59**	**83.57**	**85.59**	**116.00**	**86.04**	**65.05**
Skewness	-0.77	-	-	76.00	-1.646	0.13
Kurtosis	0.26	0.002	0.036	-0.36	3.016	-2.66
J-B Statistic	1.11	0.67	-	1.37	2.21	0.97
Probability	0.01	0.08	3.077	0.24	0.15	0.03
		0.00	0.18			
			0.03			

Source: Own Computation

D. Correlation Statistics

Generally, correlation analysis attempts to determine the degree and direction of relationship between two variables under study. In a bivariate distribution, if the variables have the cause and effect relationship, they will have high degree of correlation between them. The co-efficient of correlation is denoted by "r". The correlation is studied using Karl Pearson's correlation formula.

N Σxy - (Σx) (Σy)

r = --- (Karl Pearson's correlation formula)

√ (N Σx2 – (Σx)2) (N Σy2 – (Σy)2)

Pearson's correlation analysis is used to see the relationship between liquidity management and profitability of the firm. If efficient liquidity management increases profitability, one should expect a negative relationship between the indicators of liquidity management and profitability. Nonetheless, concern must be practiced while translating the Pearson relationship coefficients since they can't give a dependable pointer of relationship in a way which controls for extra illustrative factors. Analyzing simple bivariate correlation in a conventional matrix does not take account of each variable's correlation with all other explanatory variables (Padachi, 2006). It is for this reason, our main analysis will be derived from appropriate regression model designed for our study. The results of correlation coefficients of SKSMPL and SSFL are demonstrated in table 5 and table 6.

Table-V: Correlations Statistics of Bharat Financial Inclusion Limited

	ROI	CR	SQR	DER	CATA	OSS
ROI	1					
CR	-.039	1				
	(.942)	.				
SQR	-.113	.997(**)	1			
	(.832)	(.000)	.			
DER	-.386	.203	.252	1		
	(.449)	(.699)	(.630)	.		
CATA	-.393	-.314	-.296	-.633	1	
	(.441)	(.544)	(.569)	(.177)	.	
OSS	.545	-.067	-.122	-.939(**)	.513	1
	(.264)	(.900)	(.818)	(.006)	(.298)	.

Source: Own Computation ** Correlation is significant at the 0.01 level (2-tailed).

Table-VI: Correlations Statistics of SSFL

	ROI	CR	SQR	DER	CATA	OSS
ROI	1					
	.					
CR	-.194	1				
	(.712)	.				
SQR	-.135	.951(**)	1			
	(.798)	(.004)	.			
DER	-.498	.142	.280	1		
	(.315)	(.789)	(.591)	.		
CATA	-.233	-.297	-.514	-.549	1	
	(.657)	(.568)	(.297)	(.260)	.	
OSS	.478	-.496	-.674	-.785	.701	1
	(.338)	(.317)	(.142)	(.064)	(.121)	.

Source: Own Computation **Correlation is significant at the 0.01 level (2-tailed).

E. Multiple Regression Statistics

Multiple regression analysis has been applied to study the joint influence of the independent variables (liquidity, solvency and operational self-sufficiency indicators) on the profitability (ROI) of the MFIs. In this study, current ratio, super quick ratio, debt-equity ratio, current asset to total asset and operational self-sufficiency have been taken as the explanatory variables and return on investment has been used as the explained variable. The following regression model has been designed for this present study:

$ROI = \alpha + \beta_1 CR + \beta_2 SQR + \beta_3 DER + \beta_4 CATA + \beta_5 OSS + \varepsilon_t$ (unexplained variables or error terms)

Where, α, β_1, β_2, β_3, β_4 and β_5 are the parameters of the ROI line.

To reduce the number of financial ratios, numerous MDS runs on the SPSS were performed using different combination of ratios. For each function constructed, the model fit will be assessed on how strong was the function, how well it single out and checking the classification matrices for predictive accuracy as well. A study by Moyer (1977), using the enter method showed that even though the stepwise method uses less variables in the model, the results obtained are useful for the all eight years as compared to the results obtained using the enter method. Multiple regression analysis of both the MFIs has been tabulated in table 7 and table 8.

Table-VII: Multiple Regressions Analysis of Bharat Financial Inclusion Limited

Regression Coefficient						
Effect	Coefficient	Standard Error	Std. Coefficient	tolerance	t	p-Value
Constant	-148.613	65.397	-	-	-2.272	0.264
CR	-1.311	0.571	-0.302	0.811	-2.296	0.261
DER	0.494	1.528	0.135	0.080	0.323	0.801
CATA	-26.966	4.390	-0.999	0.531	-6.143	0.103
R=0.993	R^2=0.986		Adjusted R^2= 0.930		S.E. of the estimate = 2.23061	

F statistics= 17.545	Durbin-Watson=2.655	R^2 change = 0.986	P-value of F change =0.177

Table-VIII: Multiple Regressions Analysis of SSFL

Regression Coefficient						
Effect	Coefficient	Standard Error	Std. Coefficient	tolerance	t	p-Value
Constant DER	45.431 -3.207	20.700 2.795	- -0.498	1.000	2.195 -1.148	0.093 0.315
R=0.498	R^2=0.248		Adjusted R^2= 0.060		S.E. of the estimate = 14.43480	
F statistics= 1.317	Durbin-Watson=1.945		R^2 change = 0.248		P-value of F change =0.315	

IV. INTERPRETATION OF RESULTS

Table 3 and table 4 shows that liquidity ratios (CR and SQR) of the two leading MFIs during the period of study were satisfactory as its averages were higher than its grand benchmark, which was taken as yardstick. This demonstrates they have had the capacity to meet their developed current commitments in consistently under the examination time frame. But coefficient of variation of such ratios was lower than grand benchmark except SQR in case of SKSMPL. However, solvency ratios (DER and CATA) were better than the grand benchmark. This indicates that the companies under the study have been able to meet their matured debt obligations in time. Coefficients of variation of these two ratios were also lower than the benchmark. In the matter of the management of solvency, it shows less consistency during the study period of these companies. Lower variability indicates proper or more efficient management of fund as the excess liquidity have been used for investment purposes thereby enabling the company to follow a path of growth.

Again, important indicator of self-sufficiency (operational self-sufficiency) was satisfactory as its averages were more or less greater than the grand benchmark, which indicates that both the MFIs must be able to cover up all direct operational costs, the cost of borrowed funds and loan, and loss reserve to achieve short-term and long-term operational self-sufficiency to fully compensate for the effect of inflation on the capital base. It has been also found that coefficient of variation was lower than the grand benchmark, which indicates more consistency of management's ability to achieve its self-sufficiency in terms of more surplus and able to meet direct operational costs.

Table 5 and table 6 reveals that both the liquidity ratios (CR and SQR) as well as solvency ratios (DER and CATA) were negatively associated with profitability in case of both the MFIs under the study. This means that the result is in support of the expectation that traditional liquidity and solvency ratios were inversely related with profitability. The results of correlation coefficient were significant at 1 per cent (asterisk) level.

The strength of the relationship between the dependent variable, ROI and all the independent variables taken together and the impact of these independent variables on the profitability are given in table 7, in the case of SKSMFL. As expected, it was observed that an increase in CR and CATA by one unit; the ROI of the firm decreased by 1.311 and 26.966 units. The multiple correlations among the dependent variable ROI and the independent variables taken together were 0.993. It indicates that the profitability was highly responded by its independent variables. It is also evident from the value of R^2 that 98.6 per cent of variation in ROI was accounted by the joint variation in independent variables. Adjusted R-square (R^2) signifies that 93.0 per cent of the positive variations in the ROI were explained by the independent variables. Standard error of the regression coefficients being low (2.23061), it reveals that there exists line of estimates among the variables.

In the case of SSFL (table 8), it was observed that an increase in DER by one unit, the ROI decreased by 3.207 units. The multiple correlations among the dependent variable ROI and the independent variables taken together were 0.498. It indicates that the profitability was less responded by its independent variables. It is also evident from the value of R^2 that 24.8 per cent of variation in ROI was accounted by the joint variation in independent variables. Adjusted R-square (R^2) signifies that 6.0 per cent of the positive variations in the ROI were explained by the independent variable. Low standard error of regression coefficients (14.43480), demonstrates that there exists line of estimates among the variables.

However, for the MFIs an insignificant variability in profitability could be the result of the composite effect adopted in the analysis as well as many other performance management related unexplained variables.

V. CONCLUSIONS

The optimal of liquidity management could be achieved by a firm that manages the trade off between profitability and liquidity management indicators. The purpose of this study is to investigate the efficiency of firm's liquidity management and its relationship with firm's profitability as well. Descriptive statistics discloses that liquidity management and solvency of both the MFIs under the study were satisfactory. As of our expectation, we have also found negative relationship between the indicators of liquidity and profitability in the case of both the MFIs. This implies that the profitability of the firm could be enhanced at the expense of liquidity and solvency. The results of our study are in line with the findings of Eljelly (2004), who also found a negative relationship between the measures of liquidity and profitability for a sample of Saudi Arabian companies. Thus, managers should be well concerned about various measures of liquidity management, especially unexplained variables in the purpose of creating MFIs wealth.

VI. LIMITATIONS OF THE STUDY

The study goes through certain limitations. As the study is purely based on two leading MFIs, we could not compare with the data and information of other top MFIs. Moreover, the ratios used in the study are taken from CMIE data base which leave some grounds for error.

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COMPARATIVE ANALYSIS OF CONCEPTUAL RAINFALL-RUNOFF MODELING IN CHHATTISGARH, INDIA

Shohrat Ali[1], Rahul Kumar Jaiswal[2], Birendra Bharti[3] and Chanchal Kumari[4]
[1,4]P. G, Centre for Water Engineering and Management, Central University of Jharkhand Brambe, Ranchi
[2]Scientist-D, National Institute of Hydrology, Bhopal
[3]Assistant Professor, Centre for Water Engineering and Management, Central University of Jharkhand, Ranchi

ABSTRACT
Rainfall-runoff modeling is indispensable tools for hydrological research. Runoff estimation isquite influential for watershed development as its value has vital importance for most of the hydrological analysis.The major artifact for the hydrologist is Runoff estimation in the developing countries where the most of the watersheds are ungauged. There are different models for estimating runoff such as SWAT, HEC-HMS, HEC-RAS, MIKE SHE, MIKE NAM 11 etc.The proposed research work focused on the use of Rainfall Runoff Library (RRL) which incorporates five models such as Australian Water Balance Model (AWBM), Tank model, Soil Moisture and Accounting Model (SMAR), Sacramento model and Simhyd model. It has 8 calibration optimizer and 10 objective functions.This study comparedthe AWBM model and Tank model for its relevance in terms of performance and efficiency in Tandula catchment of Chhattisgarh, India.This paper undertakes 20 years daily rainfall, evapotranspiration and runoff data for simulation from 1995 to 2014. Runoff is estimated for 20 year period. The calibration has been carried out from 1995 to 2004 and validation from 2005 to 2014. The training and testing values for AWBM model based on Nash Sutcliffe efficiency and genetic algorithm optimizer were found 0.784 and 0.769 respectively and for Tank model, the values were found 0.837 and 0.791 respectivelyduring calibration and validation. Through the analysis it is revealed that Tank model performed better than AWBM Model in term of Nash Sutcliffe efficiency. This analysis shows a good relation between simulated and observed runoff. This can be used for predicting the runoff for extended period.

Keywords: RRL, AWBM, Tank Model, Nash Sutcliffeefficiency, Genetic algorithm optimizer.

1. INTRODUCTION
The Hydrological cycle is a model of the movement of water through the earth system. Water is formed on the earth in the forms of rivers and lakes. It is an easy and direct source of irrigation, industry and domestic use which is primarily obtained from precipitation. This rainfall reaches the water body through rainfall- runoff process. Runoff is one of the most important parameter of this cycle. Runoff monitoring or estimation is necessary because it plays a vital role for the watershed development and for most of the hydrological analysis, civil works, planning for the optimal use of reservoir, organizing rivers and flood warning.

In general, various hydrological and metrological data has been used through rainfall-runoff models for runoff estimationof the catchment. The rainfall runoff models are mainly divided into three categories black box, conceptual model and physically based model. Black box model derive the variable parameters and model structure with the help of time series. It is purely based on the available data. It does not include any catchment characteristics. The lumped model on the other hand represents processes in terms of the algebraic equation which attempts to approximate the solution to the governing differential equation. The model ignores the spatial variability and treats the catchment as a homogeneous unit. These models do not have information about topography, soil type, pattern and vegetation cover. In distributed models the watershed is divided into smaller sub basin or hydrological units each being described by separate value of model parameters. The model calculates the spatial variability in the physical characteristics of catchment. The main problem with fully distributed physical model is the requirement of more numbers of data and thus it is not widely accepted.With the rapid development in computer science and technology lots of computer based hydrological models have been developed which are used for the estimation of runoff in different catchments at present. Some of them are SWAT, HEC-RAS, HEC-HMS, GSSHA, WINSRM, WETSPA, MIKE SHE, PRMS, and MIKE 11 NAM etc.

The present paper isbased on theRainfall Runoff Library (RRL) which is lumped conceptual model and it is developed by co-operative research centre for catchment hydrology (CRCCH) Australia. It can be freely accessed through http://www.toolkit.net.au/Tools/RRL. Presently, it contains five rainfall-runoff modelsnamely, Australian Water Balance Model(AWBM), Sacramanto, Simhyd, Soil Moisture and Accounting Model (SMAR), and Tank, 8 calibration optimizers, 10 objective functions and 3 types of distinct data transformation for comparison against the data observed. In library,the calibration optimizer includes Uniform random sampling, Pattern search, Multi start pattern search, Rosenbrock search, Rosenbrock multi-start, searchGenetic algorithm, Shuffled complex evaluation (SEC-UA) and AWBM custom optimizer. Furthermore, the objective

functions included in the library are Nash-Sutcliffe criterion (co-efficient of efficiency), Sum of square error, RMSE, Root mean square difference about bias, Absolute value of bias, Absolute value of bias, Sum of square roots, Sum of square of the difference of square root and Sum of absolute difference of the log.

A lumped conceptual rainfall runoff model is AWBM which estimates daily and monthly basis runoff from the input daily rainfall, evaporation and daily runoff (Boughton et al. 2007). Generally the model works on water balance equation i.e. $store_n = store_n + rain - evaporation$ (n=1, 2, 3). The model divides the whole catchment area into 3 sub area. That sub area is represented by A_1, A_2 and A_3 respectively. The default parameter of these sub areas are $A_1=0.134$, $A_2=0.433$ and $A_3=0.433$. The summation of these areas is approximately equal to $1(A_1+A_2+A_3=1)$. It comprises of three surface moisture stores i.e. C_1, C_2 and C_3. These storages capacities are partially occurring of the catchments. On the other hand Tank is a very simple model. There are four tanks in it which are laid vertically in the series. In this model occursprecipitation only at the top of the tank and sequentiallysubtracted evaporation from top tank to bottom tank. If each tank is emptied the evaporation shortfall is taken from the next tank down until all tanks get emptied.

As hydrological Modeling lead to have lots of uncertainties in it, Many researchers have put their immense contribution such as Makungo et al. 2010, Jeong et al. 2010, Gibbs et al 2008, Boughton et al.2007, Boughton and Walter 2009, Clanor et al. 2016, Tarricone and John 2016, Nguyen et al. 2017, Niemi et al 2017, Patel et al. 2017, Najmaddin et al. 2017, Nayak and Jaiswal 2003, Mashall et al 2004, Kunz et al 2013, Haque et al 2015 etc.

The present study compared between AWBM model and Tank model based on its suitability in terms of performance and efficiency in Tandula catchment of Chhattisgarh region of India.

2. STUDY AREA
The present study is Tandula catchment which is in Balod district of Chhattisgarh region of India. Data has been collected from four rain gauge stations which are Balod, Gondli, Chamra, and Bhanpura. The study area comprises of 867.64 km^2 areas. The proposed catchment is of Tandula River. It is the tributary of Shivnath and sub tributary of the Mahanadi River. Tandula dam has been constructed on Tandula River in Balod district of Chhattisgarh which provides water primarily for irrigation agriculture, domestic purposes and for Bhilia steel plant. The geographical location of the catchment is $81^0 0'0''E$ longitude and $20^0 45'0''N$ latitude.
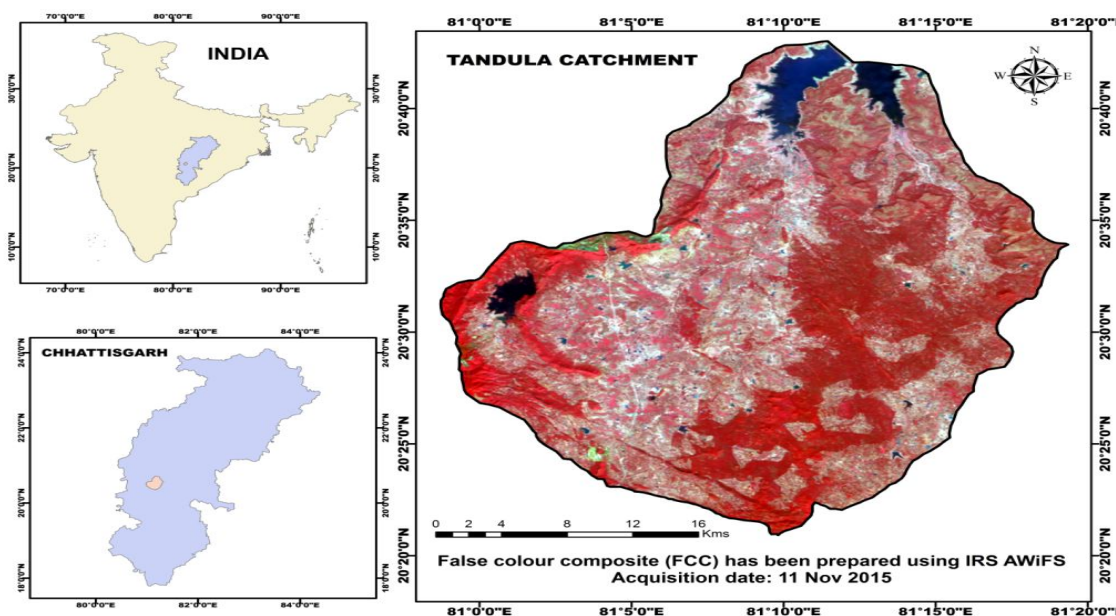
Fig-2.1 Location map of the Tandula catchment

3. MATERIALS AND METHODS
3.1 AWBM (Australian Water Balance Model)
A lumped conceptual rainfall runoff model is AWBM as shownin figure 3.1, which estimates daily and monthly runoff from the input daily rainfall, evaporation and daily runoff. Basically, AWBM model works on water balance equation i.e.

$\Delta Volume = \sum Input - \sum Output$ or $store_n = store_n + rain - evaporation$ (n=1, 2, 3)   …. (i)

The model divides the whole catchment area into 3 sub area. That sub area represented by A_1, A_2 and A_3 respectively. The default parameter of these sub area are $A_1=0.134$, $A_2=0.433$ and $A_3=0.433$. Actually summation of these areas is equal to $1(A_1+A_2+A_3=1)$. It also consists of three surface moisture stores i.e. C_1, C_2 and C_3. Those storages capacities are partially occurring of the catchments.

There are two assumptions for AWBM model:

i. The runoff is lowest during periods of low rainfall (because whole water infiltrate into the ground)

ii. The runoff becomes more with sustained rainfall (because once the ground is saturated with water, less water will infiltrate).

When any sub area comes on the verge of saturation with rainfall then runoff occurs from those areas, the runoff obtained recharge the base flow. The recharge of the base flow and surface runoff store is estimated by the following equations

$$\text{Base flow recharge} = \text{BFI} \times \text{Excess (runoff)} \quad \text{......... (ii)}$$

$$\text{Surface runoff recharge} = (1 - \text{BFI}) \times \text{Excess} \quad \text{........ (iii)}$$

The base flow and surface runoff are estimated by below equation

$$\text{Base flow discharge} = (1 - K_b) \times \text{BS} \quad \text{........ (iv)}$$

$$\text{Surface runoff discharge} = (1 - K_s) \times \text{SS} \quad \text{........ (v)}$$

Where, BFI= Base flow index, K_b= Base flow recession constant, K_s= Surface runoff recession constants, BS= current volume in Base flow store, SS= current volume in surface routing store.

The ratio of the base flow to the total flow is known as BFIin the stream. It is the only that model which have automatic calibration method. In this model calibration is done on the set of an observed runoff sequence that could be separated into calibration verification data sets.

Table-3.1: Values of the default parameter of AWBM model

S. No.	Parameter	Default	Minimum	Maximum
1	A_1(Partial area of the smallest store)	0.134	0	1
2	A_2(Partial area of the middle store)	0.433	0	1
3	BFI(Base flow index)	0.350	0	1
4	C_1(Capacity of smallest store)	7	0	50
5	C_2(Capacity of middle store)	70	0	200
6	C_3(Capacity of Largest store)	150	0	500
7	KBase(Base flow recession constant)	0.950	0	1.00
8	KSurf(Suraface flow recession constant)	0.350	0	1.00

PARAMETERS AND STATE VARIABLES :

C1-C3 = Surface Storage Capacities
A1-A3 = Partial Areas Represented by Surface Storages
BFI = Baseflow Index
K = Daily Baseflow Recession Constant
BS = Current Volume in Baseflow Store (*)
KS = Daily Surface Flow Recession Constant
SS = Current Volume in Surface Routing Store (*)
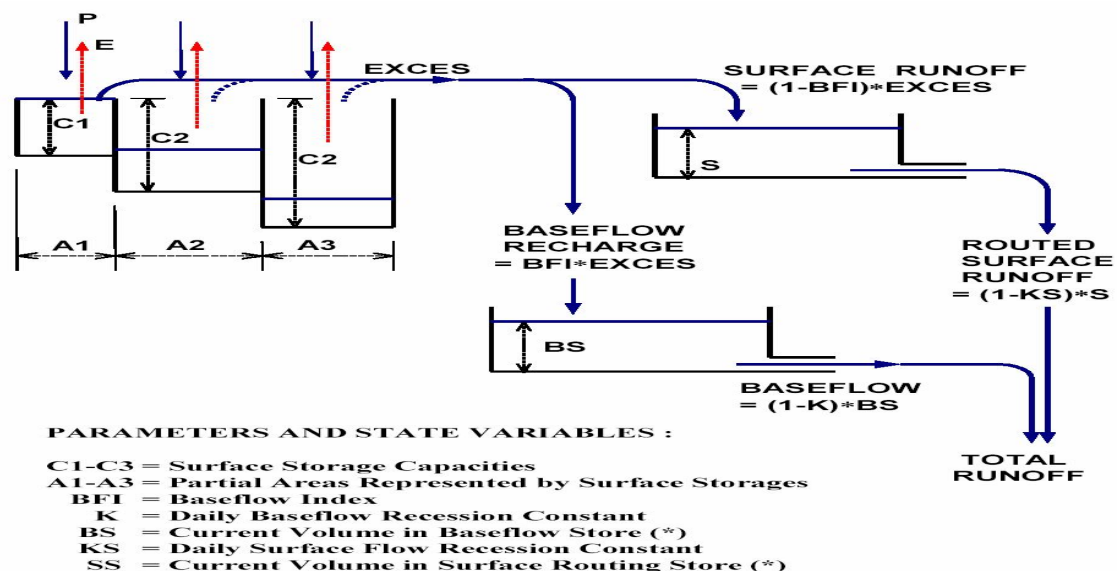
Fig-3.1: Australian Water Balance Model structure

3.2 Tank MODEL

Tank model is a very simple model and it consists of four tanks which are laid vertically in series. Precipitation occurs in the model only at the top tank and sequentially subtracted evaporation from the top tank to bottom tank. The evaporation shortfall is taken from the next tank down until all tanks are empty. If each tank is emptied, the top tank is considered as output from the surface runoff. Output given from the second tank is known as intermediate runoff, from third tank as sub-base runoff and fourth tank is consider as base flow. The tank model is not so simple its complex behavior and the nature of the model is strongly influenced by the content of each of the stores. It consists of same rainfall and different storage volumes that generate significant difference in the runoff data or value.

This model is basically used to examine the daily discharge on the basis of daily precipitation and evaporation input. The initial loss of precipitation is not considered of this model because its effect is considered in the non-linear structure of the tank model. In each tank stored water affects the amount of rainfall, infiltration, evaporation and runoff. The storages are calculated from top to bottom tank. The evaporation loss takes place from the first storage to the maximum of the potential rate. The remaining potential evaporation is taken for each of the lower tanks until all of the tanks have been evaporated.

After evaporation has been taken from the tanks rainfall is added to the top tank and based on the revised level runoff and infiltration is estimated. This is subsequently deducted from the storage level. The next tank sub subsequently receives the infiltration from the above tank. The process continues down through the other tank. Figure 3.2 shows the structure of the model.

In this model runoff, evapotranspiration and infiltration is estimated using some mathematical formulations which are discussed in the subsequent sections.
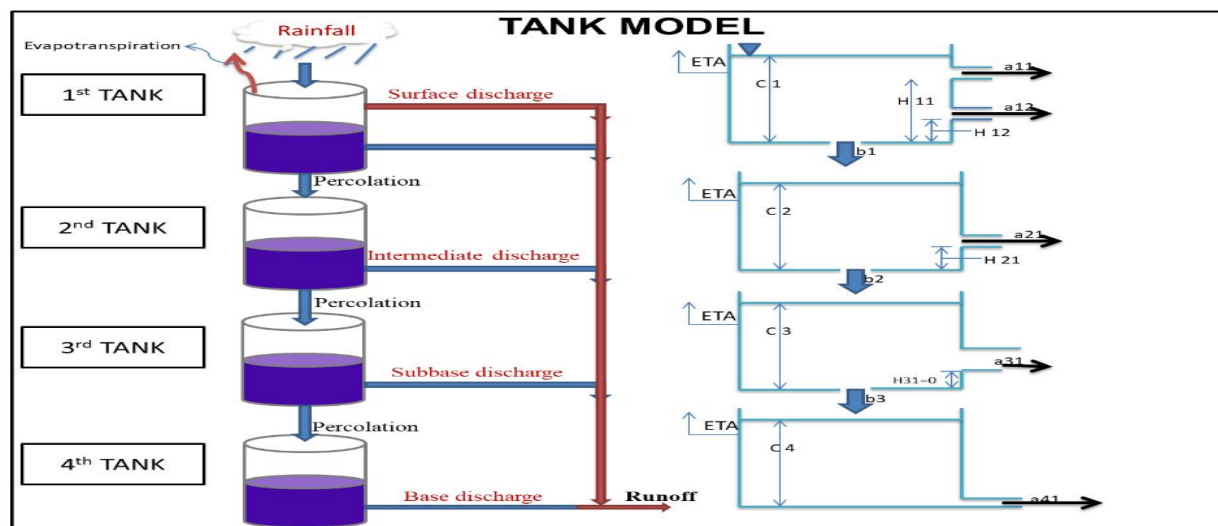
Fig-3.2: Tank Model Structure

Runoff

The total runoff is calculated as the sum of the runoff s from each of the tank. The runoff from each tank is calculated by

$$q = \sum_{x=1}^{4} \sum_{y=1}^{nx}(C_x - H_{xy})\alpha_{xy} \quad \text{.........................} \quad (i)$$

Where q is the runoff depth in mm, C_x water level of tank x, H_{xy} is outlet height and

α_{xy} is runoff coefficient of respective tank.

Evapotranspiration

The evapotranspiration can be calculated by Beken's (1979) equation

ETA=ETP*(1-exp (-$\alpha \sum C_x$))................................... (ii)

ETA=Evapotranspiration in mm, α the evapotranspiration coefficient (0.1) and

C_x is the water level of tank.

Infiltration

The infiltration in each tank is calculated by equation

$$I_x = C_x B_x \qquad\qquad \text{(iii)}$$

Where I_x=Infiltration in mm, C_x=Water level of tank X and B_x=Infiltration co-efficient tank X

Table 3.2 Values of the default parameter of Tank Model

S. No.	Parameter	Default value	Default minimum	Default maximum
1	H11(1st Outlet height of tank 1)	0	0	500
2	a11(Runoff co-efficient of tank 1)	0.2	0	1.0
3	a12(Runoff co-efficient of tank 1)	0.2	0	1.0
4	a21 (Runoff co-efficient of tank 2)	0.2	0	1.0
5	a31(Runoff co-efficient of tank 3)	0.2	0	1.0
6	a41(Runoff co-efficient of tank 4)	0.2	0	1.0
7	Alpha(Evpt. Coeff.)	0.2	0	1.0
8	b1(Infiltration co-efficient of tank 1)	0.2	0	1.0
9	b2(Infiltration co-efficient of tank 2)	0.2	0	1.0
10	b3(Infiltration co-efficient of tank 3)	0.2	0	1.0
11	C1(Water level of tank 1)	20	0	100
12	C2(Water level of tank 2)	20	0	100
13	C3(Water level of tank 3)	20	0	100
14	C4 (Water level of tank 4)	20	0	100
15	H12(2nd Outlet height of tank 1)	0	0	300
16	H21(Outlet height of tank 2)	0	0	100
17	H31(Outlet height of tank 3)	0	0	100
18	H41(Outlet height of tank 4)	0	0	100

4. RESULTS AND DISCUSSION

RRL model i.e. AWBM and Tank Model has been used to develop rainfall runoff model in the Tandula catchment of Balod district of Chhattisgarh. The weighted average rainfall of Tandula catchment has been estimated using Thiessen polygon approach. For checking the consistency of rainfall- runoff records, a linear relation between the annual rainfall and runoff is established and the correlation coefficient value obtained is recorded to be 0.726.

4.1 Comparative analysis of AWBM model and Tank model

The data used for modeling with both the models are daily weighted rainfall, daily potential evapotranspiration and daily observed discharge data and weighted catchment area.

Calibration is a process of finding out the accuracy from the observed value. It thus helps in driving correction factor that can be applied to generate predicted value and so the models were calibrated from 1st January 1995 to 31st December 2004. The models arethen run into auto calibration mode. The model parameters thus fixed during auto calibration mode were again calibrated to get the best match between the observed and simulated runoff. The optimized value of both the model parameters are listed below (Table 4.1 and Table 4.2)

Table-4.1: Optimized Value of AWBM Model Parameter

S. No.	Parameter	Optimized parameter value	Range of the Parameter
1	A_1(Partial area of the smallest store)	0.134	0.000 – 1.000
2	A_2(Partial area of the middle store)	0.433	0.000 – 1.000
3	BFI(Base flow index)	0.501	0.000 – 1.000
4	C_1(Capacity of smallest store)	7.25	0 – 50
5	C_2(Capacity of middle store)	185.88	0 – 200
6	C_3(Capacity of largest store)	496.07	0 – 500
7	K_{base}(Base flow recession constant)	0.94	0.000 – 1.000
8	K_{surf}(Surface flow recession constant)	01	0.000 – 1.000

Table-4.2: Optimized Value of Tank Model

S. No.	Parameter	Model parameter Final values	Parameter Range
1	H11(1st Outlet height of tank 1)	356.86	0 -500
2	a11(Runoff co-efficient of tank 1)	0.536	0-1.0
3	a12(Runoff co-efficient of tank 1)	0.011	0-1.0
4	a21 (Runoff co-efficient of tank 2)	0.7	0-1.0
5	a31(Runoff co-efficient of tank 3)	0.19	0-1.0
6	a41(Runoff co-efficient of tank 4)	0	0-1.0
7	Alpha(Evapotranspiration co-efficient)	3.96	0- 5
8	b1(Infiltration co-efficient of tank 1)	0.027	0-1.0
9	b2(Infiltration co-efficient of tank 2)	0.298	0-1.0
10	b3(Infiltration co-efficient of tank 3)	0.63	0-1.0
11	C1(Water level of Tank 1)	64.3	0-100
12	C2(Water level of Tank 2)	20	0-100
13	C3(Water level of Tank 3)	61.56	0-100
14	C4 (Water level of Tank 4)	23.9	0-100
15	H12(2nd Outlet height of tank 1)	182.35	0-300
16	H21(Outlet height of tank 2)	10.19	0-100
17	H31(Outlet height of tank 3)	81.5	0-100
18	H41(Outlet height of tank 4)	16.86	0-100

The output of comparison between the observed and simulated runoff for calibration in AWBM model and Tank model respectively, is shown below (Figure 4.1 and figure 4.2)
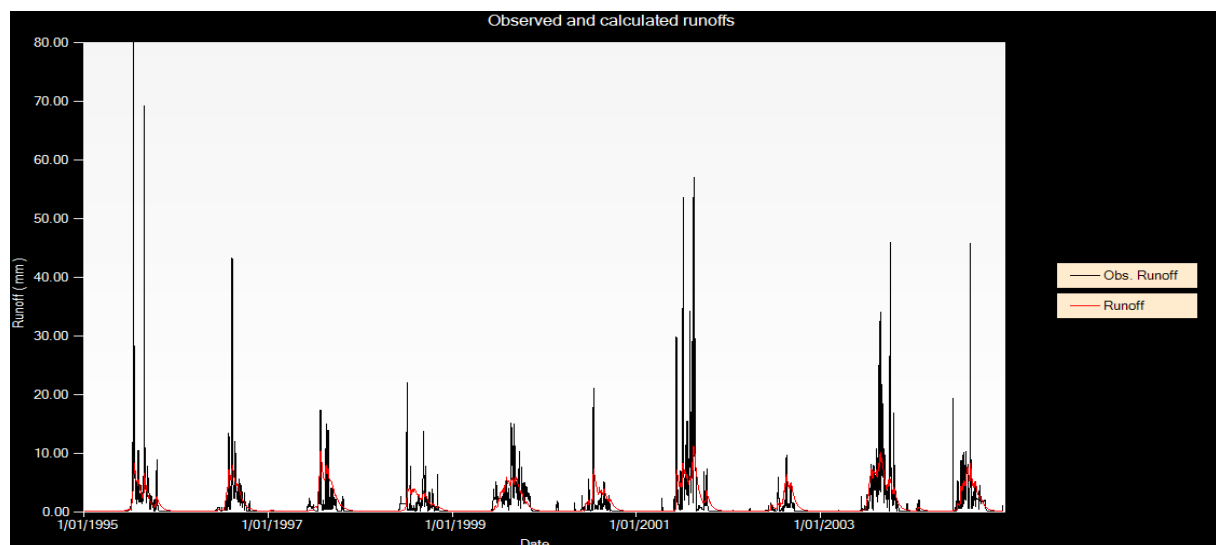
Fig 4.1 (a) Comparison between observed and simulated runoff for calibration period (1995-2004) in AWBM
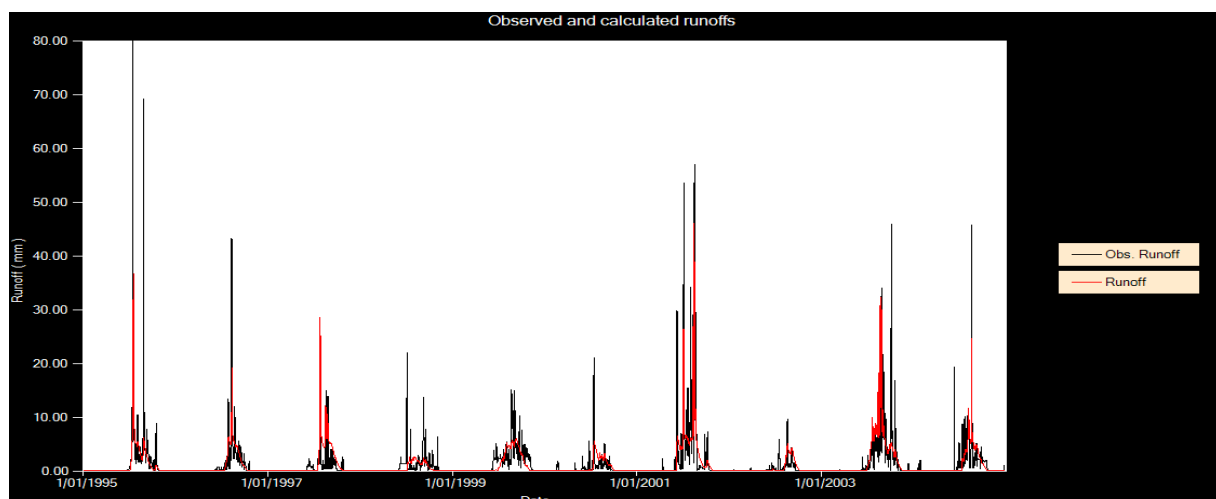
Fig 4.2 Comparison between observed and simulated runoff for calibration period (1995-2004) in TANK model
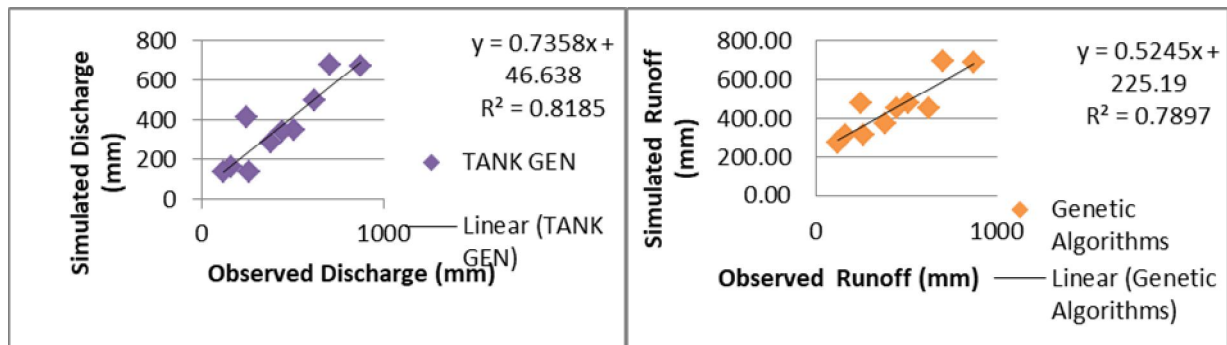
Fig 4.3 Scatter plot of observed and simulated runoff for the calibration period (1995-2004) in TANK model and AWBM respectively

Model Validation basically tests the ability of the model to estimated runoff for period outside that have been used to calibrate the model. Both the models have been run for its validation using calibration model parameter and data of remaining period from the year 2005 to 2014. Based on the performance of both models, the different evaluation criteria have showed in the Table 4.3. Nash Sutcliffe Efficiency is found better for TANK Model as compared to AWBM model. In addition to it fig 4.4 and 4.5 shows the comparison between observed and simulated runoff for validation from 2005-2014 through Model output diagram for AWBM and TANK model. Figure 4.6 states the scatter plot of observed and simulated runoff for the validation period.

Table-4.1: Evaluation Criteria table of AWBM and TANK model validation period (2005-2014)

Evaluation criteria	AWBM model	TANK RRL model
Coefficient of Determination (R^2)	0.61	0.745
Coefficient of Correlation (r)	0.78	0.86
Nash Sutcliffe Efficiency (NSE)	0.787	0.81
Root Mean Square Error (RMSE) (mm)	170.60	155.60

Fig.4.4 Comparison between observed & simulated runoff for validation in AWBM (2005-2014)

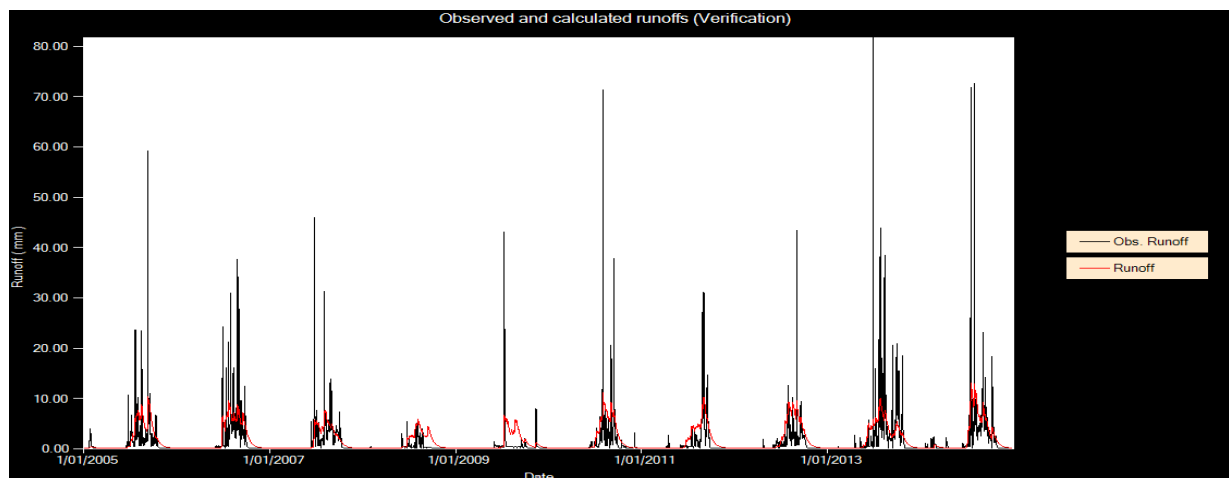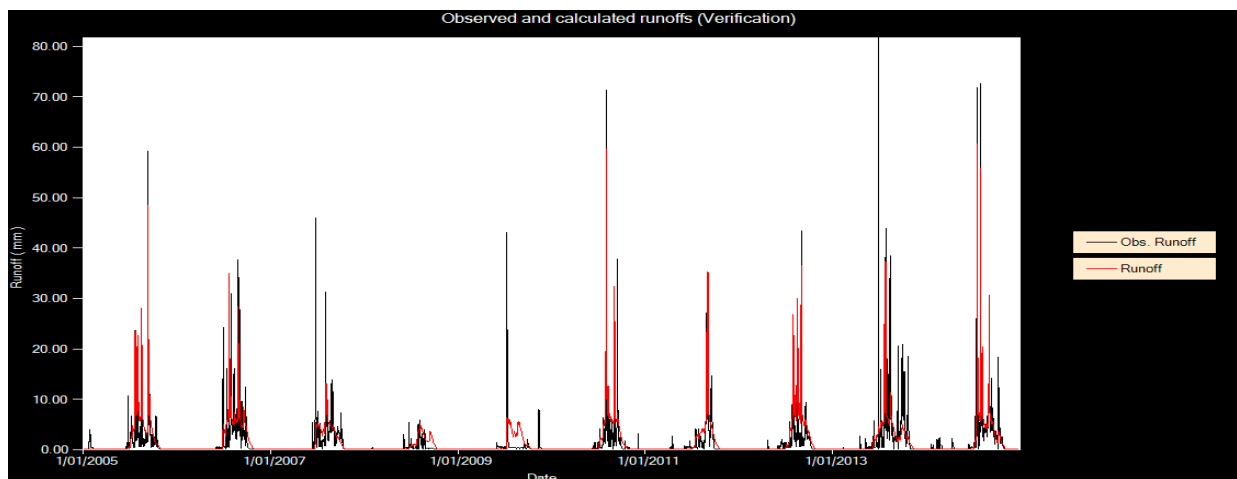Fig. 4.5 Comparison between observed & simulated discharge for validation in TANK model (2005-2014)
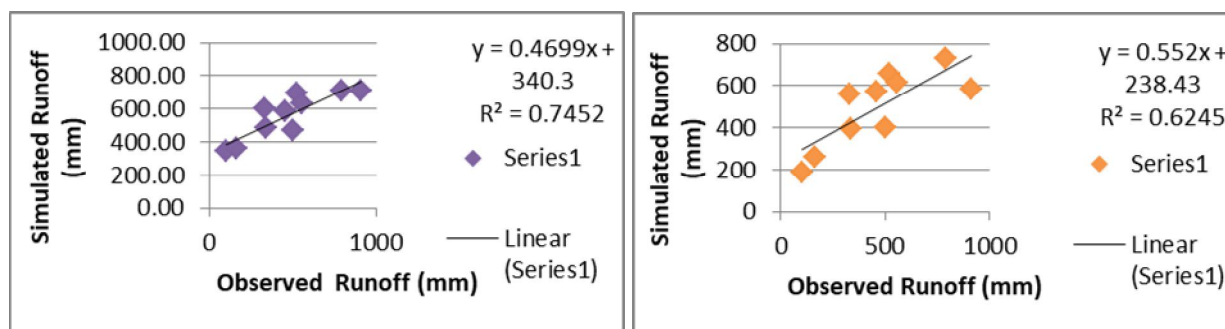
Fig. 4.6 Scatter plot of observed and simulated runoff for the validation period (2005-2014) in TANK model & AWBM respectively.

CONCLUSIONS

The Paper corresponds to the following conclusions based on the above study

i. The AWBM model showsNash Sutcliffe efficiency (NSE), Root mean square error (RMSE), Coefficient of correlation (r) and Coefficient of determination (R^2) as 0.76,129.57, 0.88 and 0.789 respectively for calibration and 0.787, 170.6, 0.78and 0.61 respectively for validation, which were satisfactorily close to the observed values.

ii. The TANK model shows Nash Sutcliffe efficiency (NSE), Root mean square error (RMSE), Coefficient of correlation (r) and Coefficient of determination (R^2) as 0.843, 122.6, 0.9 and 0.81 respectively for calibration and 0.81, 155.6, 0.86 and 0.745 respectively for validation, which were satisfactorily close to the observed values.

iii. The comparative study of the two models indicates that both the models are working well and found suitable for runoff simulation in Tandula catchment, however, the TANK model was found more effective and efficient as compared to the AWBM model.

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CONCEPTUAL INTERPRETATION WITH APPLIED ASPECT OF SROTAS

Dr. Hirdesh Kumari[1] Dr. Murlidhar Paliwal[2]
M. D.[1] and Associate Professor & HOD[2], Department of Samhita And Sanskrit, Faculty of Ayurveda, I. M. S., BHU, Varanasi

ABSTRACT
Srotas are the anatomical as well as functional entities in the body. Anatomically, srotas are hollow structures constituted of predominantly akasha mahabhhuta. Functionally, they are the channels of transportation, also performing other functions like exudation, oozing, filtration, permeation. Human body is considered as the consortium of these channels. However, Caraka and Susruta have different opinion, with logical reasons, about the number and contemplation of certain channels as srotas. Portrayal of these channel system by various ancient scholars reveals that the structural and functional integrity of this system could be correlated with the physiological state and the derangement of their integrity with the pathological state. Besides, srotas also carry utmost importance in treatment procedures like shodhana therapy for being the site of pathogenesis (kha-vaigunya and srotodusti).

Keywords: Ayurveda, srotas, channels, dhatu, srotodusti, kha-vaigunya.

INTRODUCTION
The term *srotas* is derived from the root word *'srugatau'* with suffix *'Asun'* and *'tut'* through *'Sruribhyam tut ca' sutra*. Definition of *srotas* mentioned in *Caraka Samhita* is "*Sravanat Srotansi*". General meaning of *srotas* is channels of transportation, the channels through which process of *sravana* occurs. The word *srotas* is derived from "*Srusravane*" *dhatu* which means exudation, oozing, filtration, permeation. Anatomically, *srotas* are hollow structures constituted of predominantly *akasha mahabhuta*. They are of varying size from small to large and straight or reticulated in shape. Their color is similar to that of the *dhatu* they carry within them. *Srotas* are scattered in whole body as the tendrils or branches of a tree.

It is stated in *Ayurveda* that types of *srotas* in this body are equal to the number of physical entities present in this body. All the entities of human body neither originate nor get decrease without *srotas* because all the formed elements are carried from one place to another through these channels only. This reveals that all the physical entities within this body have their own separate channels; the origin and destruction of each and every entity in this body is by means of these channels only; and, the process of transportation of finally formed elements occurs through these channels. It is noticed when looked from historical perspective that *Caraka* and *Susruta* were the first to correlate the structural and functional integrity of this system to physiological state and the derangement of their integrity to the pathological state.

AIMS AND OBJECTIVES
This study work emphasizes over the exploration of concept of *srotas* and its scientific validation in relation to both physiological functioning as well as pathological activities, along with their role in treatment of various ailments.

CONCEPT OF *SROTAS*
To understand the concept and functioning of *srotas* various synonyms have been mentioned which are *sira, dhamani, rasayani, rasavahini, nadi, marga* etc. These synonyms signify that any type of space or path in body which are the means of transportation could be considered as *srotas*. Some scholars hold the view that the human body is nothing but the conglomeration of *srotas* only because of their pervasion all over the body, and also, because the aggravators of the *doshas* (unwholesome regimes etc) and alleviators of *doshas* (wholesome regimes etc) move through the entire body through these channels. But *acarya Caraka* disagrees with this fact and stated that the elements which compose them, the elements they carry, the elements to which they provide nourishment and their abodes (muscles etc)- they all are different from these channels. They serve two fold functions i.e. serve as conduits through which the *prasada dhatu* as well as the *mala dhatu* are transported and as structure containing pores from which these *prasada* and *mala dhatus* pass to and from the *sthayi dhatu*. On this basis, *acarya Caraka* has considered even *sira* and *dhamana* as *srotas* but *Susruta* hadn't accepted the same. According to him, character of *srotas* is according to its accomplishment in respects of *sravana* or *cyavana* form (oozing/ discharge/ distribution), thus functionally separating it from *sira* and *dhamani*. According to *Vagbhata*, very minute pores of *srotas* which are innumerable and present everywhere in body, are the means of expansion of *rasadhatu* in whole body. These *srotas* could be compared with the fine channels and pores present in the lotus stem. The way very minute pores are present in lotus stem, in the same way are

present in *srotas* through which the process of transportation of *rasa* etc. *dhatu* to various organs and their part reaches.

1) ROLE OF *SROTAS* IN BODY

For each and every physical entity in body there are *srotas* specific for them. Among the basic principles of *Ayurveda,* the fundamental principle of *srotas* has their unique identity as the proceeding of *Ayurvedic* principles like *Dhatu-poshana, sharira-kriya, Vikarotpattisiddhanta* etc. all are based on the concept of *srotas*. This makes it an important concept. All the fully formed *dhatu* are taken to their destination only by means of *srotas*. In another words, *srotas* are the passage of nourishment in body because the phenomenon of *visarga, adana* and *vikshepa* are done by means of *srotas. Cakrapani Dutta* has mentioned specificity about *srotas* function. He observed that *Sthira-dhatus* are not transported by *srotas* but only the *dhatus* which are under the process of metabolic transformation viz. the *asthira-dhatus* are transported. The *sthayi-dhatus* are formed consecutively from the *poshaka dhatus* which are carried by their distinct *srotas*, for which various *dhatuposhana nyayas* such as *kedarikulya nyaya, khale-kapota nyaya* etc have been mentioned. Although *mana* is not the *poshya*, even then it moves to all the *indriya* (sense organs) for which whole the sentient portion of body is said to be the *srotas* of *manas*. This reveals that both *Sthula* as well as *Sukshma srotas* are the means of transportation (*vahana-madhyama*) in our body. *Sukshma srotas* could be considered as cells, cell membrane, intercellular spaces, intracellular spaces while *sthula srotas* can be compared with the alimentary canal, blood vessels (arteries, veins etc), lymphatic channels etc. Thus, *srotas* play key role in the normal physiology of body.

2) ROLE OF *SROTAS* IN OCCURRENCE OF DISEASES

Srotas have equivalent role in disease occurrence as in the maintenance of normal physiology. *Acarya Caraka* has said that all *srotas* are the channels or means of transportation for mobile *doshas (vata, pitta* and *kapha)*. In this way, to those entities which can't be seen by eyes (*mana, buddhi* etc.), whole body including soul is the channel. When these *srotas* are in normal state, body is said to be healthy while in vitiated condition *dhatus* in these channels gets vitiated. Those vitiated *srotas* and their respective *dhatus* leads to vitiation of further *dhatus*. Vitiated *srotas* vitiate other *srotas* and vitiated *dhatus* to the others. The main culprit behind all these derangements of *srotas* and their respective *dhatus* are *vata, pitta* and *kapha* because these vitiated *tridoshas* have the tendency to vitiate the *dhatus. Acarya Vagbhata* says that *tridosha* have got the property or nature of deranging other factors so that they first get vitiated by following the spacious channels and then vitiates the respective *dhatus. Acarya Caraka* also said same thing that those *ahara-vihara* which have got properties similar to *doshas* and opposite to *dhatus* first vitiates the *tridosha* after that these *doshas* vitiates or deforms the *srotas. Susruta* stated that vitiated *doshas* travels in the body but disease occurs only where *srotodusti* exists, which means *srotodusti* is necessary for any disease. Thus, made clear the importance of *srotas* in the pathogenesis of diseases. In context of *grahani, Caraka* explained that after digestion of ingested food, the formed *rasa dhatu* is carried to whole body by *vyanavayu* for the nourishment of rest *dhatus*. During its passage, this *rasadhatu* where ever finds any abnormality in *srotas,* stops there and leads to pathogenesis of disease.

DISCUSSION

Any kind of physiological or pathological activity requires a medium or channel for transportation of products. These channels within the body are named as *srotas*. Describing about the number of *srotas* within body, *acarya Caraka* and *Susruta* have different opinions. *Acarya Caraka* has mentioned *srotas* as either innumerable or grossly 13 *srotas* in body, while *acarya Susruta* has mentioned only 11 pairs of *srotas*. The reason behind this is that *acarya Susruta*, being a surgeon, has described *sthula-srotomula* and symptoms of their injury because these symptoms reveal the prognosis of each *srotas*. Moreover, *Susruta* mentioned only 11 pairs of *srotas* and did not considered the *mula* of *asthivaha, majjavaha* and *svedavaha srotas* as they are not confined to one part of the body but all pervasive. Also, symptoms of injury to the *mula* of these *srotas* anywhere within the body do not reveal their prognosis. Again, *sukshma srotas* possess specific symptoms which also do not reveal the prognosis. Thus he declined these *asthivaha, majjavaha* and *svedavaha srotas* in grosser form. On the other hand, *acarya Caraka*, being a physician, described the concept of both *sthula* and *sukshma srotas*; and mentioned the symptoms of *srotodusti* depending upon the normal physiological functions of the *srotas*, rather than the *srotomula-viddha* symptoms. This is why, *acarya Caraka* considered and counted *asthivaha, majjavaha* and *svedavaha srotas*.

All the minute individual units (cells) are considered as *anu* or *sukshma srotas* and all different individual organ systems (gross) are considered as *sthulasrotas*. All the *sthulasrotas* are different from each other and due to this one type of *srotas* nourishes one *dhatu* and not the other. For example, *raktavaha srotas* nourishes *rakta dhatu*

only and not the *mansadhatu* or *meda dhatu*. This is because the nourishing destinations of each *srotas* are different *dhatus*. On the other hand, for the three *doshas, vata, pitta* and *kapha, atindriya mana, buddhi* etc the whole body and all the channels (*srotas*) becomes passage as well as lodge. For them there is no differentiation of *srotas* and thus, signifies the concept of *sukshma srotas*. Another point of view regarding form of *srotas* is *bahirmukha srotas* and *antarmukha srotas*. Thus, the numerable *srotas* which are 13 in number could be accepted as *sthulasrotas*, while the innumerable *srotas* could be accepted as *suksma* or *anu srotas*. *Susruta* counted 9 big holes of the body as *sthulachidra* whereas *Kashyapa* included them in both *sthula* and *sukshma chidra* and named them *srotas*. This reveals that what so ever space is present within the body, is *srotas*. The space present in between the two organs or anatomical structures as well as the space present within the structure is *srotas*.

Srotas is primarily physiological as well as anatomical unit. They are required for each and every physiological function to occur in the body. *Srotas* are as important in our body as the roads in our life. These are the only means through which transportation of *ahara rasa, dosha, dhatu* and mala occurs. Transportation of these factors from one place to other is necessarily required for the maintenance of normal physiological activities within the body. All the *nyaya* (maxims) describing in detail, the process of *dhatu-poshana*, whether *kedari-kulya, khale-kapota, ekakala dhatu poshana* and other; represent the significance of *srotas* in *dhatu- poshana*. They provide passage for the transportation of the fully formed *dhatu. Prana* are transported within whole body and to its each small unit. Life is impossible without *Prana* and it needs a medium or channel for its transportation which are named as *srotas*. As life is impossible without *Prana*, in similar way existence of body and sustenance of its normal physiology is impossible without *srotas*.

Srotas plays a major role in pathogenesis of any disease too, as in the maintenance of normal physiology. They are the root site of any disease. When the pathogenesis begins, *srotas* are the first to get affected. Basically, *srotas* means 'kha' or 'akasha' or space. '*Kha-vaigunya*' is necessary for the '*sthana-sanshraya*' of the vitiated *dosha* and pathogenesis of disease. As described in *kriya-kala* of *vyadhi, srotas* is required in stage of *dosha-sancaya, prakopa, prasara, sthana-sanshraya*. This unveils that origination of all the *nija-vyadhis* involves the principle of '*kha-vaigunya*', whether the process takes place at minute level or at gross level. Thus, it is clear from discussion that *srotas* are involved in both anatomical as well as physiological pathologies. Anatomical pathology and its related disorders have been explored by *acarya Susruta* while *acarya Caraka* emphasized on the physiological pathologies of the *srotas*.

The principle of *srotas* occupies prime position in the field of treatment also. *Ayurveda* stands with the fundamental principle of 'with-root elimination of diseases'. These roots are nothing other than anomaly in *srotas* from where the disease originates and without purification of *srotas (sroto-vishodhana)* the disease cannot be cured completely. Hence, for this, the concept of *shodhana* and *shamana cikitsa* was explored. The *shodhana* therapy is specifically refers to *srotas* purification, so that the chances of recurrence of disease get abolished or minimized.

Use of different types of diet and regimes in the present era, without considering the time, place, season and other factors, resulted in the diseases like hypertension, cardiac disorders etc which are nothing but the resultant of *sroto-vaigunya*. This provides more gravity to understand the concept of *srotas* in pathogenesis of disease as well as in the treatment procedures.

CONCLUSION

1) *Srotas* are structural as well as functional unit of body.

2) All ancient scholars have almost similar opinion about *srotas* but explained it according to their subject matter.

3) *Srotas* are involved in both anatomical as well as physiological pathologies.

4) They occupy prime position in the field of treatment also i.e. the concept of srotas is essential to be considered while deciding the diet, drug and/ or therapeutic procedure for any disease.

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EFFECT OF HEALTH WARNING LABELS OF TOBACCO ON CONSUMERS' RISK PERCEPTION

Shishpal[1] and Dinesh Kumar[2]
Research Scholar[1], Haryana School of Business, Guru Jambheshwar University of Science and Technology, Hisar
Assistant Professor[2], Govt. College, Hisar

ABSTRACT
Purpose- Objective of this research paper is to examine the consumers' perception of health warning labels of tobacco products.

Research Methodology- 560 Respondents were selected by using stratified convenient sampling method from four administrative divisions of Haryana. A structured questionnaire was designed to examine consumers' of health warning labels. Statistical tools like t-test, one way ANOVA s tests were used to analyze data with the help of SPSS.

Findings: The current study indicates that there is positive influence of health warning labels of tobacco products on consumers' perception. Tobacco consumers of Haryana who are using tobacco which consuming tobacco products since more than fifteen years have positive effects of health warning labels on consumers' perception which leads to not to use tobacco.. Graduate and post graduate respondents have positive effects of health warning labels on consumers' perception of using tobacco than low educated respondents

Implications- Majority of respondent have given most importance to pictured, large size, colored health warning labels motivate people to quit tobacco and convey health associated risk in better way which depicts that, these factors plays a crucial role from government and social marketers point of view and these factors should be the prime consideration while making strategies for making health label more effective to reduce the tobacco consumption.

Keywords: Health warning labels, Health Risk, Perception and Tobacco etc.

1.0 INTRODUCTION
Health warnings on tobacco packages, especially those combine text and pictures, are one of the most cost-effective and powerful ways to increase public awareness of the serious health risks of tobacco use and reduce consumption. The current and potential tobacco users may comprehend that tobacco is harmful; studies show that few understand its specific health risks. Effective health warnings have been proven to motivate users to quit and to reduce the appeal of tobacco to people who are not yet addicted, particularly youth (WHO).

Generally people think safe about themselves when they compare the similar health risks with others. Risk has been defined in a number of ways, but is often seen as the likelihood that an individual will experience the effect of danger (Short Jr, 1984). Wherever it is discussed, it seems to be a consensus about essence of risk as being consisting of the probability of an adverse event and the magnitude of its consequences (Rayner and Cantor, 1987). In other words, in any definite situation, an adverse outcome may or may not occur and causative factors skew the probabilities of diverse outcomes (Graham and Rhomberg, 1996). Risk perceptions are beliefs about potential harm or the possibility of a loss. It is a subjective judgment that people make about the characteristics and severity of a risk (Slovic, P. 1987). The health warning labels are pictured on the package of every tobacco product. Health warning labels on cigarette packs inform smokers about the health associated risks of smoking, urge smokers to stop and keep away nonsmokers to smoke. Warning labels on tobacco items are a perfect method for communcating with smokers since they combine the notice straightforwdly with consumer smoking behavior. According to the U.S. Surgeon General, "health warnings on cigarette packages are a direct, cost-effective means of communicating information on health risks of smoking to consumers." (U.S. Department of Health and Human Services [USDHHS] 1994)

In the past, labels just wordings have showed up on cigarette packages. It is demonstrates that photo based labels with going with wordings are more effective. Health warning labels on tobacco products packages are a financially savvy approach to spread data to the general population on the risks of smoking furthermore, benefits to quit tobacco products. Health warning labels messages seem most broadly and reliably on fabricated cigarette packs. Other sorts of tobacco items, for example, stogies (cigar) or smokeless tobacco may have distinctive health warning labels. Tobacco warning labels an effective method of communicating the health hazards of smoking; moreover, the warning an opportunity for motivating reductions in smoking behavior (Strahan, et. al, 2002). Claudia et. al. (2013) found that teachers were already aware of tobacco-related health

risks. To further increase awareness of these risks, the inclusion of evidence-based facts in messages was recommended communicating risk information using negative emotions had a great appeal to teachers.

2.0 REVIEW OF LITERATURE

Health warning labels portray the harmful effects of tobacco items with massages or images. The messages in the labels are designed to depict the unsafe physical and psychosocial impacts of consuming tobacco products. The impact of health warnings depends upon their size and design. Unclear text-only warnings have little effects, well-known health warnings on the face of packages increase health knowledge, perceptions of risk and can promote smoking cessation. In addition, pictorial health warnings that elicit strong emotional reactions are significantly more effective (Hammond, 2010)

Victoria White et al. (2008) suggested that graphic warning labels on cigarette packs are noticed by the majority of adolescents and have the potential to lower smoking intentions. Findings also suggested that the introduction of graphic warning labels may help to reduce smoking among adolescents. Pictorial HWLs with didactic textual forms and graphic imagery of diseased organs are likely to have broad impact on the population (Thrasher, et al. 2011). Jennifer Cantrell et.al (2013) supported that the pictorial warning labels have the greater impact compared to the text-only warning is consistent across diverse racial/ethnic and socioeconomic populations.

Robert G. Brubaker and Suzanne K. Mitby (1990) found that the presence of warning and content of warning labels does have any effect on tobacco consumer's intentions to use smokeless tobacco. Male respondents are better able to recall the content of the warning message which they see than female.

A majority of both smokers and nonsmokers endorsed the use of Canadian labels in the United States. Canadian-style warnings to be adopted in the United States as part of the country's overall tobacco control packages strategy and related accessories (Peters, et al, 2007). Borland (2009) found that warning labels size increases effectiveness and graphic warnings are superior to text-based warnings. Canadian cigarette warning labels were more visible and informative than U.S. cigarette warning labels. There is no significant difference is found in effects of health warning labels on basis education level. Some differences are found for warning labels with sex-specific messages (Michelle O'Hegarty et.al, 2007).

Health warning labels on cigarette packages increase awareness of health risks among smokers and non-smokers and decrease consumption of tobacco. Health warning labels on waterpipe tobacco products and accessories is potentially more challenging than on cigarette packages because packaging often comes in different shapes and sizes. Misleading descriptors were placed on waterpipe tobacco (Rima Nakkash and Joanna Khalil, 2009). Melindaa Stanley (1996) revealed that smokers reported significantly less belief in the validity of the health warning labels than nonsmokers. Smokers also indicated less belief in the messages than ex-smokers.

Large, comprehensive warnings on cigarette packages are more likely to be noticed and rated as effective by smokers. Changes in health warnings are also associated with increased effectiveness (Hammond et.al, 2007) Minsoo Jung (2016) found that the impact of Graphic warning labels (GWLs) as a preventive effect on adolescents' smoking, inducement of smoking cessation, reduction in the amount of tobacco smoked, and reduction in smoking rates. The success of an anti-smoking policy can manifests itself as an effect of individual policies, the rise of tobacco prices, and the introduction of GWLs.

After reviews the literature it is concluded that large, clear and pictured health warning labels have positive effect on health risk of using tobacco products. Most of the researchers found that health warning labels on tobacco products have positive influence on the consumers' behavior to not initiate tobacco and quit tobacco.

2.1 OBJECTIVE OF THE STUDY

The study examines the consumers' perception of health warning labels of tobacco products.

Followings hypothesis have been formulated in the study:

H_{a1}= There is a significant difference in the consumers' perception of health warning labels of tobacco products on the basis of area of living.

H_{a2}= There is a significant difference in the consumers' perception of health warning labels of tobacco products on the basis of years of using tobacco products.

H_{a3}= There is a significant difference in the consumers' perception of health warning labels of tobacco products on the basis of age.

H_{a4}= There is a significant difference in the consumers' perception of health warning labels of tobacco products on the basis of education levels.

3.0 RESEARCH METHODOLOGY

Haryana is divided into four administrative divisions by Government of Haryana. The four administrative divisions of Haryana acted as sub groups or strata and from these strata respondents were selected using convenience sampling making the overall sampling criteria as stratified convenience sampling. One district is selected from each administrative division these were Panipat, Hisar, Rewari and Kurukshetra. The present study is based on empirical analysis of examining effect of health warning labels on consumers' risk perception. A total of 600 questionnaires were distributed in these administrative zones of Haryana. 560 questionnaire were found fit for the data analysis, which leads to final sample size of 560. To make the present examination comprehensive in nature, information was gathered from the tobacco consumers of different demographic profiles.

Table-1: Demographic profile of the respondents

Demographic Variable		Frequency	Percentage
Age (years)	20-30	273	48.8
	30-40	130	23.2
	Above 40	157	28.0
Gender	Male	477	85.2
	Female	83	14.8
Education	Up to 7th	123	22.0
	8- 12th	133	23.8
	Graduate	153	27.3
	Postgraduate& above	151	27.0
Marital status	Unmarried	204	36.4
	Married	356	63.6
Area of living	Rural	324	57.9
	Urban	236	42.1
Using tobacco since (years of using tobacco)	0-5	243	43.4
	6-10	133	23.8
	11-15	65	11.6
	Above 15	119	21.2

Source: Survey Data

Table 1 indicates demographic profile of the respondents. Age, gender, education qualifications, marital status, area of living and years of using tobacco constitute the demographic profile of the respondents. In the total sample 48.8 percent respondents were between the ages 20 to 30 years. It means near about half of the total sample was younger. 23.2 percent respondents between the age of 30-40 and 28 percent were above 40 years of age. 85.2 percent respondents were male tobacco consumers and only 14.8 percent were female tobacco consumers. 22 percent respondents were educated up to 7th class, 23.8 percent were at 8-12th level. 27.3 percent respondents were graduate and 27 percent were post graduate & above. 57.9 percent were rural tobacco consumers and 42.1percent were residing at urban areas. 43.4 percent tobacco consumers were using tobacco products since 0-5 years, 23.8 percent were using since 6-10 years, 11.6 percent were using since 11-15 and 21.2 percent were using tobacco since more than 15 years.

To examine the consumers' perception of health warning labels of tobacco products, the questionnaire consisting of 11 simple understandable statements (Table 2) on a five point Likert scale ranging from strongly agree to strongly disagree was used in the study. The scoring of the items range from 5 to 1 for strongly agrees to strongly disagree respectively. The data was analyzed with the help of descriptive measures such as frequency and percentage. The hypotheses have been tested by using t-test and one-way analysis of variance (ANOVA).

Table-2: Items of the Questionnaire

Item No.	Item description
D1	Health warning labels on tobacco products reduce consumption of tobacco.
D2	Increase knowledge about quitting tobacco.
D3	Health warning labels motivate to quit tobacco.
D4	Exposure to graphic warning labels increase perception of risk using tobacco products.
D5	Health warning labels on tobacco products change users' attitude toward tobacco products.

D6	Health warning labels make you feel to stay away from tobacco.
D7	Pictured health warning improves perception of health risk.
D8	Large size and colored health warning labels on tobacco products convey health associated risk in better way.
D9	A clear, direct and accurate massage of warning labels reduces tobacco consumption.
D11	Pictorial health warnings on tobacco products motivate people to quit tobacco.
D12	Health warning labels help in perceiving the risk of using tobacco products.

4.0 DATA ANALYSIS

Most practiced index of internal consistency in social sciences researches on multi-item measures, the Cronbach alpha (Schmitt, 1996) was used to check reliability in present study. 11 statements of questionnaire were subjected to alpha test of reliability; the Cronbach alpha statistic for 11 statements was .874 showing that scale is reliable.

Table-3: consumers' perception of health warning labels of tobacco products

Item No.	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
D1	55(9.8)	82(14.6)	68(12.1)	150(26.8)	205(36.6)
D2	56(10)	60(10.7)	65(11.6)	190(33.8)	189(33.8)
D3	39(7.0)	64(11.4)	46(8.2)	195(34.8)	216(38.6)
D4	38(6.8)	69(12.3)	60(10.7)	206(36.8)	187(33.4)
D5	37(6.6)	67(12)	104(18.6)	180(32.1)	172(30.7
D6	64(11.4)	78(13.9)	101(18)	152(27.1)	165(29.5)
D7	63(11.2)	69(12.3)	82(14.6)	191(34.1)	155(27.7)
D8	56(10)	66(11.8)	66(11.8)	189(33.8)	183(32.7)
D9	53(9.5)	74(13.2)	73(13)	185(33)	175(31.2)
D11	53(9.5)	64(11.4)	55(9.8)	206(36.8)	182(32.5)
D12	52(9.3)	66(11.8)	63(11.2)	212(37.9)	167(29.8)

Source: Survey Data

Table 3 depicts the level of agreement among tobacco consumers regarding different items measuring the consumers' perception of health warning labels of tobacco products. The effect of health warning labels on consumers' perception was found high as observed from the frequency and percentage of the respondents indicating agreement towards the items measuring consumers' risk perception. Health warning labels also influence the behavior not to initiate using tobacco and to quit tobacco. The presence of warning labels on tobacco products increase the perceived risks of consumers.

4.1 Consumers' Perception of Health Warning Labels of Tobacco Products on the Basis of Area of Living

Table-4: Consumers' Perception of Health Warning Labels of Tobacco Products On The Basis Of Area of Living

T-Statistics				
Item No.	Rural (N=324)	Urban (N=236)	T-Value	P-Value
	Mean	Mean		
D1	3.7130	3.5805	1.140	.25
D2	3.8056	3.5720	2.096	.037**
D3	3.8611	3.8720	-.111	.911
D4	3.8395	3.6907	1.414	.158
D5	3.7407	3.6059	1.299	.195
D6	3.5216	3.4534	.593	.554
D7	3.5586	3.5297	.257	.797
D8	3.6605	3.6907	.273	.785
D9	3.6574	3.6017	.500	.617
D11	3.6111	3.8559	-2.299	.022**
D12	3.6883	3.6483	.371	.711

**Significant at 5 percent

Scrutinizing the results from the perspective of area of living of consumers revealed that, area of living does not bring any change in the consumers' perception toward the health warning labels in terms of eleven dimensions

undertaken which are Health warning labels on tobacco products reduce consumption of tobacco, motivate to quit tobacco, increase perception of risk using tobacco products, change users' attitude toward tobacco products, make you feel to stay away from tobacco, Pictured health warning improves perception of health risk, Large size and colored health warning labels on tobacco products convey health associated risk in better way, A clear, direct and accurate massage of warning labels reduces tobacco consumption and help in perceiving the risk of using tobacco products. The respondents living in rural and urban areas were found to differ significantly (p value <.05) at 5 percent in relation to only two dimensions which are health warning labels increase knowledge about quitting tobacco and pictorial health warnings on tobacco products motivate people to quit tobacco.

Overall, study revealed that area of living does not contribute any variation in the gravity of any of consumers' perception of health warning labels. Opinions of both rural and urban tobacco respondents were same consumers' perception of health warning labels.

4.2 Consumers' Perception of Health Warning Labels of Tobacco Products on The Basis of Years of Using Tobacco Products

Table-5: Consumers' Perception of Health Warning Labels of Tobacco Products On The Basis of Years of Using Tobacco Products

Item No.	ANOVA Statistics					
	0-5 (N=243)	6-10(N=133)	11-15(N=65)	<15 (N=119)	F-Value	P-Value
	Mean	Mean	Mean	Mean		
D1	3.6337	3.7669	3.6308	3.5966	.400	.753
D2	3.6749	3.8346	3.5538	3.7143	.773	.509
D3	3.7901	4.0150	3.9692	3.7983	1.214	.304
D4	3.8272	3.8496	3.5538	3.7143	1.118	.341
D5	3.6872	3.7744	3.3385	3.7647	2.199	.087
D6	3.6461	3.5489	3.0923	3.3361	3.644	.013**
D7	3.7202	3.4135	3.0923	3.5882	4.586	.003*
D8	3.8642	3.4135	3.6000	3.6134	3.674	.012**
D9	3.7778	3.4361	3.4308	3.6723	2.601	.051***
D11	3.8642	3.6090	3.2769	3.7647	4.030	.007*
D12	3.7860	3.4135	3.7385	3.6891	2.577	.053***

*Significant at 1 percent; **Significant at 5 percent; *** Significant at 10 percent

It is noticed from the results of ANOVA test (Table 5) that the consumers in the three groups on the basis of years of using tobacco do not differ significantly from each other regarding five factors namely health warning labels on tobacco products reduce consumption of tobacco, Increase knowledge about quitting tobacco, motivate to quit tobacco, Exposure to graphic warning labels increase perception of risk using tobacco products, change users' attitude toward tobacco products, make you feel to stay away from tobacco, change users' attitude toward tobacco products which support the hypothesis (H$_{a2}$).

For the remaining factors namely pictured health warning improves perception of health risk. Large size and colored health warning labels on tobacco products convey health associated risk in better way, A clear, direct and accurate massage of warning labels reduces tobacco consumption, Pictorial health warnings on tobacco products motivate people to quit tobacco and help in perceiving the risk of using tobacco products gave significant (p value <.05) results. Older tobacco consumers which consuming tobacco products since more than fifteen years have positive effects of health warning labels on consumers' perception which leads to not to use tobacco.

4.3 Consumers' Perception of Health Warning Labels of Tobacco Products on The Basis of Education Levels

Table-6: Consumers' Perception of Health Warning Labels of Tobacco Products On The Basis of Education Levels

Item No.	ANOVA Statistics					
	Up to 7th	8- 12th	Graduate	Postgraduate& above	F- value	p- value
	Mean	Mean	Mean	Mean		
D1	3.7073	3.7669	3.6536	3.5232	.836	.475

D2	3.7236	3.8496	3.6013	3.6755	.901	.440
D3	3.7724	3.9173	3.7908	3.9735	.875	.454
D4	3.6829	3.8195	3.7451	3.8477	.497	.684
D5	3.5854	3.7143	3.6471	3.7748	.628	.597
D6	3.3089	3.4211	3.6797	3.5166	1.905	.128
D7	3.1951	3.4060	3.6601	3.8411	6.541*	.000
D8	3.3252	3.6842	3.7778	3.8411	4.125*	.007
D9	3.3577	3.6015	3.7320	3.7881	2.902**	.034
D11	3.2114	3.6917	3.8366	4.0199	10.055*	.000
D12	3.4797	3.5338	3.7712	3.8477	2.766**	.041

*Significant at 1 percent; **Significant at 5 percent

Results indicate that for the factors namely Pictured health warning improves perception of health risk, Large size and colored health warning labels on tobacco products convey health associated risk in better way, A clear, direct and accurate massage of warning labels reduces tobacco consumption, Pictorial health warnings on tobacco products motivate people to quit tobacco, Health warning labels help in perceiving the risk of using tobacco products irrespective of the education level of respondents were found significantly (p value <.05) different among various groups of tobacco consumers, which supports the hypothesis (H_{a4}). Graduate and post graduate respondents have positive effects of health warning labels on risk perception of using tobacco than low educated respondents.

Variance across various groups for the factors namely Health warning labels on tobacco products reduce consumption of tobacco, Increase knowledge about quitting tobacco, motivate to quit tobacco, Exposure to graphic warning labels increase perception of risk using tobacco products, change users' attitude toward tobacco products, make you feel to stay away from tobacco is homogeneous. There is no significant difference found in groups.

Opinions of all consumers were not different regarding effects of health warning labels on consumers' perception of using tobacco except the above mentioned five factors (D7, D8, D9, D11, D12,).

4.4 Consumers' Perception of Health Warning Labels of Tobacco Products on the basis of age

Table-7: Effect of Health Warning Labels on Consumers' Risk Perception on the basis of age

Item No.	20-30N=(273)	31-40(N=130)	<40(N=157)	F- value	p- value
	Mean	Mean	Mean		
D1	3.5458	3.6077	3.8917	3.377	.035**
D2	3.6227	3.7769	3.7962	1.126	.325
D3	3.7253	4.0846	3.9299	4.033	.018**
D4	3.7216	3.8846	3.7834	.784	.457
D5	3.6227	3.7615	3.7261	.709	.492
D6	3.5092	3.5231	3.4395	.176	.839
D7	3.5897	3.6000	3.4268	.908	.404
D8	3.7216	3.7846	3.4968	2.092	.124
D9	3.6960	3.6385	3.5223	.889	.412
D11	3.8352	3.7692	3.4586	4.484	.012**
D12	3.7253	3.7077	3.5478	1.043	.353

**Significant at 5 percent

Investigating the results from the perspective of age of consumers revealed that, age does not bring any change in the perception toward the effects of health warning labels. Overall, study revealed that area of living does not contribute any variation in the gravity of any of the effect of health warning labels on consumers' perception. Opinions of all age groups (20-30, 31-40, and more than 40 years) of respondents were same for effect of health warning labels on consumers' perception.

5.0 RESULTS AND DISCUSSION
The present study has confirmed that there is positive perception of health warning labels of tobacco products. Variance across the different age groups does not contribute any significant variation regarding the effects of health warning labels on consumers' perception.

Area of living (rural, urban) does not bring any change in perception towards the effects of health warning labels except two dimensions which are health warning labels increase knowledge about quitting tobacco(D2) and pictorial health warning labels motivate people to quit tobacco(D11).

When comparison is made on the basis of years of using tobacco there is a significant different is found regarding pictured health warning improves perception of health risk(D7), Large size and colored health warning labels on tobacco products convey health associated risk in better way(D8), A clear, direct and accurate massage of warning labels reduces tobacco consumption(D9), Pictorial health warnings on tobacco products motivate people to quit tobacco (D11) and help in perceiving the risk of using tobacco products (D12). For the remaining items mentioned above (table 5) opinion of the consumers' on the basis of years of using tobacco products do not differ significantly regarding the effects of health warning labels on risk perceptions.

Variance across the different education levels were not different significantly regarding pictured health warning improves perception of health risk(D7), Large size and colored health warning labels on tobacco products convey health associated risk in better way(D8), A clear, direct and accurate massage of warning labels reduces tobacco consumption(D9), Pictorial health warnings on tobacco products motivate people to quit tobacco (D11) and help in perceiving the risk of using tobacco products (D12). There is no significant difference is found for remaining items mentioned above (table 6) regarding the effects of health warning labels on risk perception.

Overall finding suggested that majority of respondent have positive attitude regarding the effects of health warning labels on risk perception. Health warning labels influence the consumers' behavior in a positive way. These outcomes appear to recommend that notice names ought to be put in a more conspicuous area on smokeless tobacco items and in smokeless tobacco publicizing keeping in mind the end goal to improve their striking nature (Robert G. Brubaker and Suzanne K. Mitby, 1990)

6.0 CONCLUSION

The current study indicates that there is positive consumers' perception of health warning labels of tobacco products. Tobacco consumers of Haryana who are using tobacco which consuming tobacco products since more than fifteen years have positive effects of health warning labels on risk perception which leads to not to use tobacco.. Graduate and post graduate respondents have positive effects of health warning labels on risk perception of using tobacco than low educated respondents.

7.0 LIMITATIONS OF THE STUDY AND SCOPE FOR FUTURE RESEARCH

In this we examined the of opinion of only tobacco consumers regarding effects of health warning labels on consumers' risk perception , not for the general public. In addition to this sample size and area (only form Haryana State) was not so big to generalize the findings of the study, lack of time and money can be termed as reason for it. Respondents additionally not react honestly can be the reason of biased data. A large portion of the tobacco consumers did not need uncover that they are consuming tobacco items. It gives us certain strong insights regarding effects of health warning labels on consumers' risk perception which will assist us while going for full fledge study on large sample size and sample area. Respondents which are not using tobacco products can be covered, others demographic groups can be included so that more focused and reliable results can be obtained.

8.0 MANAGERIAL IMPLICATIONS

Majority of respondent have given most importance to pictured, large size, colored health warning labels motivate people to quit tobacco and convey health associated risk in better way which depicts that, these factors plays a crucial role from government and social marketers point of view and these factors should be the prime consideration while making strategies for making health labels more effective to reduce the tobacco consumption.

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EFFECT OF PRANAYAMA ON SELECTED CARDIO RESPIRATORY PARAMETERS AMONG COLLEGE MEN STUDENTS

Dr. G. Kirubalan
Deputy Director, Physical Education, Chetinad Academy of Research and Education, Chennai

ABSTRACT
The purpose of the present study was to find out the effect of Pranayama practices on selected Cardio Respiratory parameters among College men students. For this purpose, 30 men college students in the age group of 18 to 22 years were selected as subjects from the College and they were divided randomly in to two equal groups with 15 each as experimental and control group. Both the group undergone usual activity in addition experimental group underwent pranayama practice daily morning 60-minutes and the control group not given pranayama practice. The training period for this study was 6 weeks in a schedule of 5 days in a week. The pre and post test were conducted prior and after the training programme on the selected cardio respiratory parameters of vital capacity and resting heart rate. The collected data's were statistically analyzed by using ANCOVA to find out the significant difference between the groups, if any. The significant level was fixed at 0.05 levels. It was concluded from the result of the study that the experimental group done the pranayama practice had significant impact on the selected Cardio Respiratory parameters of vital capacity and resting heart rate among college men students. Further the mean value indicated that the experimental group considerably increased the vital capacity and decreased resting heart rate then control group.

Keywords: Pranayama, vital capacity and respiratory rate

INTRODUCTION
Pranayama is the practice of breath control. The word prana refers not only to breath, but also to air and life itself.-Christy Turlington

Pranayama is an ancient yoga technique, which makes use of voluntary regulation of breathing and calm the mind. It differs from other forms of exercises as it mainly focuses on the sensations in the body. Pranayama thus acts directly on the various functions of the body and affords benefits in a positive way. Regular, slow and forceful inspiration and expiration for a longer duration during the pranayama practice, leading to strengthening of the respiratory muscles. It impact on the efficiency of cardiovascular function. Pranayama literally means to pause, extend and regulate the prana, the life force of the breath. It is an ancient system of working with the breath through specific techniques and retentions, which enact a direct effect on the nervous system and on the mind/consciousness (Elonne Stockton, 2015).

There are plenty of research studies conducted in pranayama in relation to cardio respiratory parameter and almost all the studies given a very strong input in improving the cardio respiratory efficiency. Ananda Kumar (2009) found that the yoga and pranayama practice significant reduction in resting pulse rate and respiratory rate. Joshi et al. (1992) and Telles et al. (1993) found significant reduction in respiratory rate, after short term yoga practices. Pramanik et al. (2009) found that slow pace bhastrika pranayama on blood pressure and heart rate found that the efficiency in the respiratory parameter. Tome Rakesh & Singh, Neelima (2011) found that ujjayi pranayama was benevolent to a significant reduction in resting pulse rate and beneficial effects of regular breathing exercises on cardio-vascular functions in normal healthy individuals.Turankar et al**.** (2013) investigated that regular practice of slow breathing has been shown to improve cardiovascular and respiratory functions. Upadhyay Dhungel et al. (2008) found that the pranayama practice decreased in pulse rate.

OBJECTIVES OF THE STUDY
The core aim of the present study was to find out the effect of pranayama practices on selected cardio respiratory parameters of vital capacity and resting heart rate among college men students.

METHODOLOGY
The selection of subjects, variables, training procedure and statistical techniques are explained below

Subject
Thirty college men students were selected as subjects for the study and they were randomly divided into two groups equally with fifteen each as experimental and control group. The age groups of the subjects were eighteen to twenty two years.

Training Procedure
The experimental and control groups were practiced athletic training evening two hours and apart from athletic training experimental group undergone one hour pranayama practice in a schedule of morning one hour for a period of six weeks. The pranayama practice includes Kapalabati, Bramhari, NadiSuddhi, Bhastrika, Suryabhedan, Ujjayi, Bhramari and Shitali.

Testing Procedure
The pre and post test were conducted prior and after the training programme on the selected cardio respiratory variables of vital capacity and resting heart rate. All the tests were carried out with standardized procedure.

Statistical Procedure
The analysis of covariance (ANCOVA) was used as a statistical tool to determine the significant difference on the data of pre and post mean obtained for vital capacity and resting heart rate between control and experimental group. The level of significance was fixed at 0.05 level of confidence.

RESULTS & DISCUSSIONS
The analysis of covariance on the data obtained on vital capacity and resting heart rate of pre and post tests are tabulated and presented in the tables I and II

Table I - COMPUTATION OF ANALYSIS OF VITAL CAPACITY

TEST	Experimental Group	Control Group	sv	Sum of Squares	df	Mean Square	F ratio
Pre test	2.75	2.75	B	1.33	1	1.33	0.0003
			W	1.202	28	0.0429	
Post test	3.23	2.92	B	0.748	1	0.748	9.529*
			W	2.200	28	0.078	
Adjusted Mean	3.23	2.91	B	0.754	1	0.753	14.006 *
			W	1.453	27	0.0538	
Mean gain	-0.48	-0.16					

*Significant at 0.05 level of confidence

It was observed from the Table-I that there was no significant difference in the pretest (F=0.0003 < 4.20). The significant differences were observed in post test (F=9.529> 4.20) for df 1 and 28 at 0.05 level of confidence and adjusted post test (F=14.006> 4.21) for df 1 and 27 at 0.05 level of confidence. There was a significant difference in vital capacity and mean score indicated that the experimental group increased the level of vital capacity than control group due to six weeks pranayama practice.

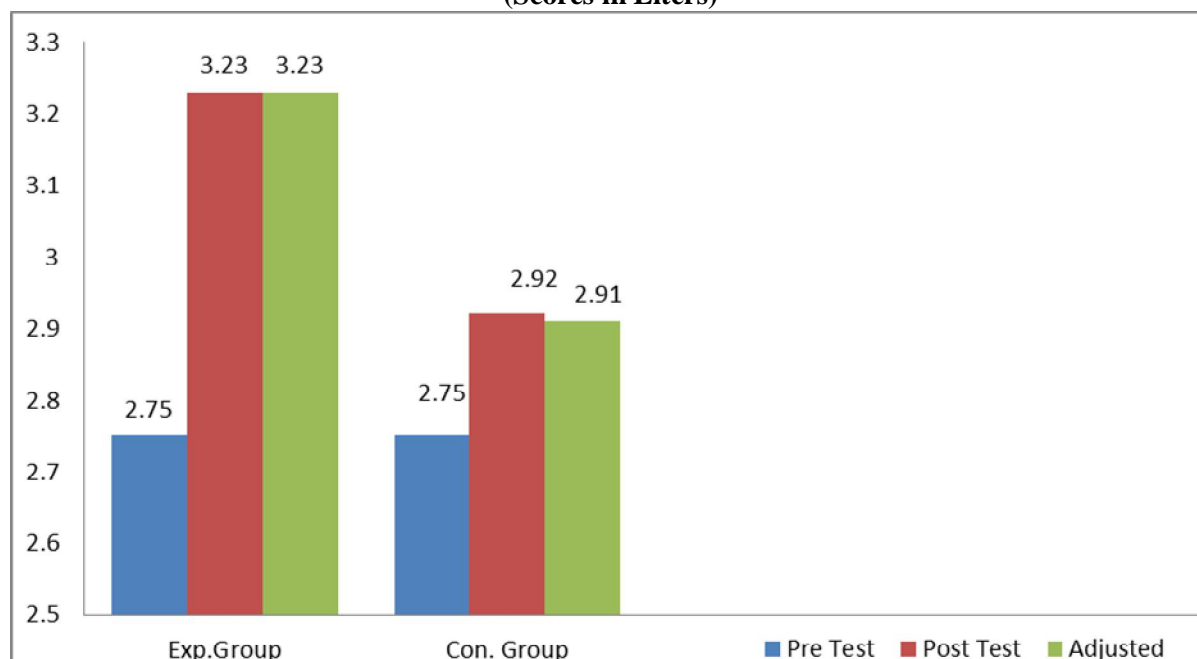**FIGURE-1: BAR DIAGRAM SHOWING THE PRE AND POST TEST MEAN OF VITAL CAPACITY (Scores in Liters)**

Table II - COMPUTATION OF ANALYSIS OF RESTING HEART RATE

TEST	Exp. Group	Con. Group	sv	Sum of Squares	df	Mean Square	F ratio
Pre test	79.13	81.26	B	34.133	1	34.133	0.11
			W	8369.667	28	298.916	
Post test	74.66	79.73	B	192.533	1	192.533	12.58*
			W	428.266	28	15.295	
Adjusted Mean	74.69	79.70	B	187.288	1	187.287	
			W	421.795	27	15.622	11.98*
Mean gain	4.46	1.53					

*Significant at 0.05 level of confidence

It was observed from the Table-II that there was no significant difference in the pretest (F=0.II < 4.20). The significant differences were observed in post test (F=12.58> 4.20) for df 1 and 28 at 0.05 level of confidence and adjusted post-test (F=11.98> 4.21) for df 1 and 27 at 0.05 level of confidence. There was a significant difference in resting heart rate and mean score indicated that the experimental group decreased the level of resting heart rate than control group due to six weeks pranayama practice.

FIGURE-2: BAR DIAGRAM SHOWING THE PRE AND POST TEST MEAN OF RESTING HEART RATE
(Scores in beats per minute)
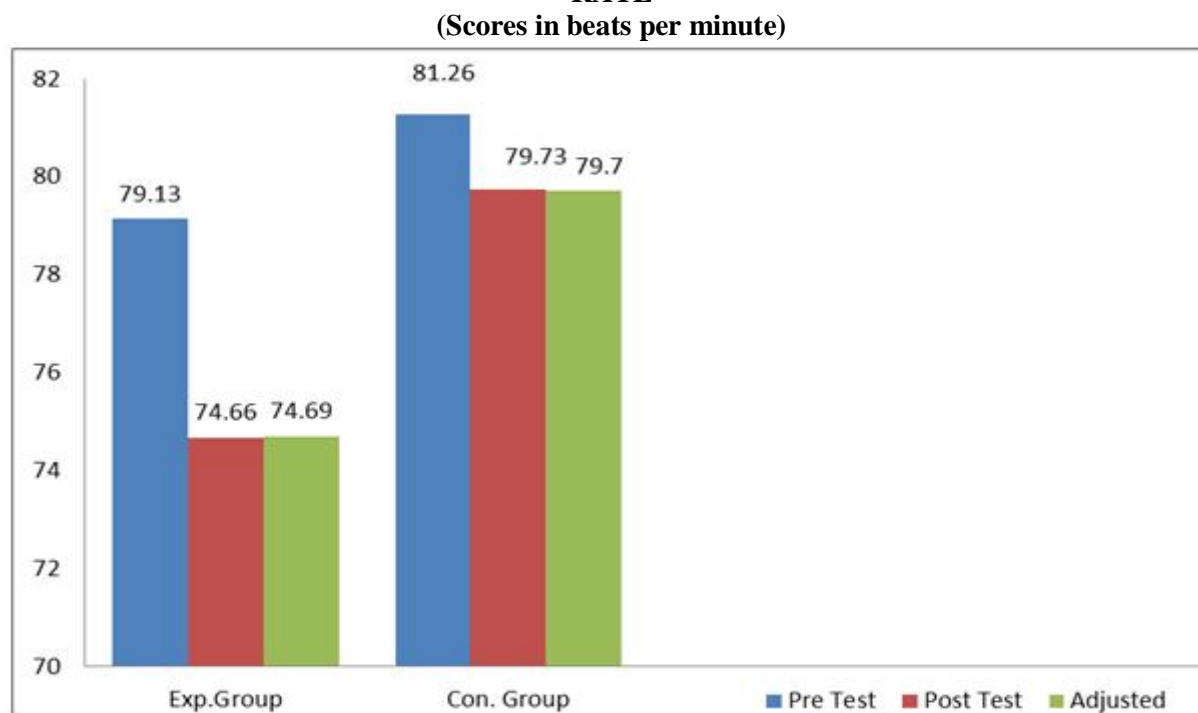
CONCLUSIONS

Based on the result of the study the following conclusions were drawn

1. Pranayama practice is benevolent to improve the cardio respiratory parameters of vital capacity and resting heart rate among college men students

2. Result of the study proved that there is a significant difference in vital capacity and resting heart rate among college men students due to six weeks pranayama practice

3. Pranayama training may be included as one of the training schedule to improve the cardio respiratory efficiency.

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FACTORS INFLUENCING PERCEIVED ORGANIZATIONAL CLIMATE OF THE EXTENSION PERSONNEL IN THE STATE DEPARTMENT OF AGRICULTURE

Dr. J. Meenambigai
Assistant Professor, Department of Agricultural Extension, Faculty of Agriculture, Annamalai University

ABSTRACT
Organizational climate can be characterised as consisting of tendency on the part of the organization, to consider people as the most important resource. It is a relatively enduring quality of the internal environment of the organization that is experienced by its members, influences their behaviour and can be described in terms of the values of a particular set of characteristics or attributes of the organization. Perceived organizational climate was operationalized in this study as the summary of individual's perceptions with respect to the organizational procedures, policies and practices. A checklist was developed to measure the perceived opinion on organizational climate by the extension personnel. It consisted of 58 items representing different characteristics of the organization. To analyze the various factors influencing the organizational climate perception the statistical tools like correlation, regression and path analysis were used. The study was conducted in Coimbatore and Madurai Districts of Tamil Nadu. The total sample size consisted of 32 ADO's, 33 AO (extn.), 26 AO (TANWA) and 53 AO (SMS). The findings of the study revealed that out of twenty two variables, job satisfaction, organizational commitment, self-motivation, integration, job performance, job involvement, trainings undergone and job perception had shown significant association with perceived organizational climate. All the 22 variables together explained 28.98 percent of variation in the perception of organizational climate among the extension personnel. Job satisfaction, leadership ability and self motivation were identified as crucial variables contributing for the change in perceived organizational climate. Further, the variables like age, job perception and job performance were identified as crucial in explaining the change in perceived organizational climate. From the above findings it was recommended to the state department of agriculture to concentrate on the identified variables as a important factors influencing the perceived organizational climate of the extension personnel.

INTRODUCTION
Agriculture is the main and only source of livelihood for over three-fourths of the population in India. The agricultural development in India has always been on the forefront for the past four decades as a result of constructive government policies and priorities formulated in agricultural sector on one hand and the dedicated efforts of the farm scientists, extension workers and farmers on the other. Agriculture in Tamil Nadu today is beset with a multitude of problems. In recent years, an innovative approach to problems has made agriculture more knowledge intensive by developing management systems, along with the application of modern technologies. In order to transfer location specific and need based package of agriculture and allied technologies in a comprehensive manner, the Government of India has advocated the Broad Based Extension system which envisaged the dissemination of agriculture and allied enterprises in an integrated manner. Hence, an attempt has been made in this study to analyze the factors influencing the perceived organizational climate of the extension personnel working under BBES in Tamil Nadu.

RESEARCH METHODOLOGY
Organizational climate is relatively enduring quality of the internal environment of the organization that a. is experienced by its members, b. influences their behaviour and c. can be described in terms of the values of a particular set of characteristics or attributes of the organization. Perceived organizational climate was operationalized in this study as the summary of individual's perceptions with despect to the organizational procedures, policies and practices. A checklist was developed to measure the perceived opinion on organizational climate by the extension personnel. It consisted of 58 items representing different characteristics of the organization. To analyze the factors influencing the perceived organizational climate, the statistical tools viz., correlation analysis, multiple regression analysis and path analysis were used. The study was conducted in 7 agricultural divisions of Coimbatore and 6 agricultural divisions of Madurai district. The total sample size consisted of 32 ADO$_s$, 33 AO$_s$ (Extension), 26 AO$_s$ (TANWA) and 53 AO$_s$ (SMS).

FINDINGS AND DISCUSSION
To analyze the factors influencing perceived organizational climate, correlation and multiple regression co-efficients were worked out in order to find out the relative association and contribution of socio-personal, job related and organizational characteristics towards the perceived organizational climate of the extension personnel. The data were collected and presented in Table 1 and 2.

CORRELATION ANALYSIS

An overview of the Table 1 revealed that out of 22 variables, eight variables had shown significant association with the perceived organizational climate. Among the eight variables, job satisfaction, organizational commitment, self-motivation and integration had shown positive and significant association with perceived organizational climate and job performance had shown negative association at 1% level of probability. The variable, job involvement had shown positive and significant association and trainings undergone and job perception had shown negative and significant association at 5% level of probability. The remaining variables had shown non-significant association.

Table-1: Zero order correlation and multiple regression of perceived organizational climate of extension personnel with independent variables

Variable No.	Independent variables	Correlation coefficient	Partial regression coefficient (b)	Standard error of regression coefficient	't' value
X_1	Age	-0.152 NS	-1.5116	1.6390	0.9223 NS
X_2	Educational qualification	-0.017 NS	-2.6246	3.1644	0.8294 NS
X_3	Experience in service	-0.131 NS	1.0026	1.5150	0.6671 NS
X_4	Trainings undergone	-0.184*	-0.2916	0.6031	0.4836 NS
X_5	Rural urban background	-0.146 NS	-2.4726	2.2341	1.1068 NS
X_6	Achievement motivation	0.131 NS	-0.0783	0.6724	0.1165 NS
X_7	Job Involvement	0.199*	0.4291	0.3875	1.1075 NS
X_8	Job satisfaction	0.339**	0.7658	0.3685	2.0781*
X_9	Organizational commitment	0.215**	0.3901	0.5827	0.6695 NS
X_{10}	Time management	0.076 NS	0.3795	1.0281	0.3691 NS
X_{11}	Leadership ability	0.021 NS	-2.9313	1.4242	2.0582 *
X_{12}	Decision making ability	0.125 NS	1.4508	1.0894	1.3318 NS
X_{13}	Self motivation	0.338**	3.1653	1.3234	2.3918 *
X_{14}	Faith in team work	-0.040 NS	-1.8494	1.9463	0.9502 NS
X_{15}	Self confidence	0.007 NS	-0.3618	1.3942	0.2595 NS
X_{16}	Technical knowledge	0.011 NS	-0.6071	1.5366	0.3951 NS
X_{17}	Feedback behaviour	0.086 NS	0.0500	1.8430	0.0271 NS
X_{18}	Co-operation	-0.122 NS	-2.8608	2.5032	1.1429 NS
X_{19}	Integration	0.237**	1.3444	1.3863	0.9698 NS
X_{20}	Communication skill	0.098 NS	0.0072	0.1636	0.0439 NS
X_{21}	Job perception	-0.195*	0.3923	0.4163	0.9424 NS
X_{22}	Job performance	-0.221**	-0.4449	0.4304	0.0336 NS

R^2 = 0.289799   * Significant at 5% level

a = 104.38684   ** Significant at 1% level

F = 2.2443**   NS – Non-significant

REGRESSION ANALYSIS

Multiple regression analysis was carried out to find out the relative contribution of each variable towards the perceived organizational climate of extension personnel.

It could be observed from the table that all the 20 independent variables taken together explained 28.98 per cent variation in the perceived organizational climate of extension personnel.

The 'F' value (2.2443) was found to be significant.

Out of the 22 variables, job satisfaction, leadership ability and self motivation contributed significantly at 5% level of probability.

This revealed that high level of job satisfaction, leadership ability and self motivation would increase the perceived organizational climate. The table further revealed that an increase in the level of job satisfaction, leadership ability and self motivation by one unit, **ceteris paribus**, would result in an increase in the perceived organizational climate by 2.08 units, 2.06 units and 2.39 units respectively.

PATH ANALYSIS

To find out the direct, indirect and substantial indirect effects of independent variables towards the perceived organizational climate, path analysis was applied and the results are presented in Table 2.

It could be revealed from the table that the variables, job perception (X_{21}) (0.30665), self motivation (X_{13}) (0.23204) and job satisfaction (X_8) (0.19956) had high direct positive effect on perceived organizational climate followed by experience in service (X_5) (0.19900), decision making ability (X_{12}) (0.12344) and job involvement (X_7) (0.12242).

The table further revealed that leadership ability (X_{11}) (0.21714), organizational commitment (X_9) (0.15167) and integration (X_{19}) (0.14948), had high indirect and positive effect on perceived organizational climate followed by achievement motivation (X_6) (0.14205), job satisfaction (X_8) (0.13981) and age (X_1) (0.13222).

Out of the 66 substantial indirect effects, 13 effects passed through job performance, 12 effects passed through job perception, 11 effects through age, 9 effects through self motivation, 6 effects through job involvement and job satisfaction, 5 effects through leadership ability, 2 effects through experience in service and one effect each through decision making ability and co-operation.

The trend of path analysis showed that the crucial variables which influenced the perceived organizational climate were job performance, job perception and age.

Table-2: Direct, indirect and substantial indirect effects of independent variables on perceived organizational climate of extension personnel

Variable No.	Independent variables	Direct effect	Indirect effect	Substantial indirect effects		
				I	II	III
X_1	Age	-0.28448	0.13222	0.19182 (X_3)	-0.12929 (Y_2)	0.12177 (Y_1)
X_2	Educational qualification	-0.07408	0.05669	0.09233 (Y_2)	-0.08136 (Y_1)	0.07539 (X_1)
X_3	Experience in service	0.19900	-0.33024	-0.27422 (X_1)	-0.12622 (Y_2)	0.11777 (Y_1)
X_4	Trainings undergone	-0.04913	-0.46539	-0.15286 (Y_2)	0.13150 (Y_1)	-0.10686 (X_1)
X_5	Rural urban background	-0.09714	-0.04933	-0.07832 (X_1)	-0.06627 (Y_2)	0.06147 (Y_1)
X_6	Achievement motivation	-0.01104	0.14205	-0.05332 (X_{11})	0.0315 (X_7)	0.05180 (X_8)
X_7	Job Involvement	0.12242	0.07615	0.08978 (Y_2)	0.07010 (X_8)	-0.06897 (Y_1)
X_8	Job satisfaction	0.19956	0.13981	0.07034 (X_{13})	0.06984 (Y_2)	-0.00697 (X_{11})
X_9	Organizational commitment	0.06335	0.15167	0.07012 (X_8)	0.05840 (X_{13})	0.05077 (X_7)
X_{10}	Time management	0.03255	0.04343	-0.08651 (Y_2)	0.07609 (Y_1)	-0.03321 (X_1)
X_{11}	Leadership ability	-0.19654	0.21714	0.08127 (X_{13})	0.06800 (X_8)	0.04611 (X_{12})
X_{12}	Decision making ability	0.12344	0.00191	0.07357 (X_{13})	-0.07341 (X_{11})	-0.02306 (X_1)
X_{13}	Self motivation	0.23204	0.10632	0.10731 (Y_2)	-0.09307 (Y_1)	-0.06883 (X_{11})
X_{14}	Faith in team work	-0.08174	0.04153	0.02998 (X_{13})	-0.02366 (X_{11})	0.02137 (X_7)
X_{15}	Self confidence	-0.02338	0.03046	0.04653 (X_7)	0.03664 (Y_2)	-0.03493 (Y_1)
X_{16}	Technical knowledge	-0.03535	0.04663	-0.05367 (X_1)	0.03721 (X_{13})	0.03546 (Y_1)
X_{17}	Feedback behaviour	0.00245	0.08403	0.06363	0.03664 (X_7)	0.03473

				(X_{13})		(Y_2)
X_{18}	Co-operation	-0.09911	-0.02267	-0.03726 (X_{13})	-0.03436 (X_1)	0.02704 (X_3)
X_{19}	Integration	0.08707	0.14948	0.05243 (X_8)	0.04353 (X_{13})	0.02517 (X_1)
X_{20}	Communication skill	0.00425	0.09402	0.04328 (X_8)	0.03273 (X_7)	-0.03223 (X_{18})
X_{21}	Job perception	0.30665	-0.50197	-0.32923 (Y_2)	0.30665 (Y_1)	-0.11297 (X_1)
X_{22}	Job performance	-0.33993	0.11845	-0.33993 (Y_2)	0.29700 (Y_1)	-0.10820 (X_1)

Residual effect = 0.8427343 $\qquad$ $R^2 = 0.2898$

CONCLUSION
It could be concluded that out of twenty two variables, job satisfaction, organizational commitment, self-motivation, integration, job performance, job involvement, trainings undergone and job perception had shown significant association with perceived organizational climate. Job satisfaction, leadership ability and self motivation were identified as crucial variables contributing for the charge in perceived organizational climate. The variables viz., age, job perception and job performance were identified as crucial variables in explaining the change in perceived organizational climate.

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IMPACT OF RESONATE ON GALVANIC SKIN RESISTANCE: BIOFEEDBACK APPROACH

Khan, Shah Mohd.[1], Mir, Suhail[2] and Khan, Zaira Seraj[3]

[1]Associate Professor and Research Scholars[2,3], Psycho-physiology Lab., Department of Psychology, A. M. U., Aligarh

ABSTRACT

The aim of this article is to study the outcome of sound on psycho-physiological measures in students. Sound exposure is associated with a number of health effects like sleep disturbance, disturbance of daily activities and performance, and physical responses, such as hearing loss, hypertension and other heart disease. Biofeedback is a therapeutic method and a means for relieving the ache, gaining control of our body procedures to augment relaxation, and developing a good health and more comfortable life patterns. Results were in favour of the framed hypothesis. The sample constituted of 21 subjects who were doing their post graduation from A.M.U., Aligarh and the age ranges from 21-24 years. Significant increase in GSR was recorded in students who were exposed to sound stress separately for each session. It was also observed that these changes were related to duration of exposure to sound stress The results stated that sound was adversely affecting the skin conductance of the subject. Implications and suggestions for further study proposed.

Keywords: Sound, Galvanic, Skin, Conductance, Biofeedback

BACKGROUND

In present scenario the human-machine interaction is going parallel and exposure to stress and strain is going into high spikes. It is well-known in our daily lives we face number of impediment and disruptions. The dominance of stress and strain in once lives makes it difficult for us to be fully focused and oriented towards goals. To overcome with these barriers our body needs to respond at optimal level and process accordingly. Response of our body needs to reflect back in such a way that focuses needs to be on our attaining goals and objectives.

The certain environmental exposure is also associated with number of health effects. The exposure of humans with different platforms where sound is an internal part of their livelihood makes their senses to adapt the environment and as the stimuli becomes their daily task they get habituated and remain continuous with their assigned work. The effect of such tasks is not incidental but shows reflection in long term basis in relation to health. Slowly it effects both psychologically and physiologically with its internal aspects such as annoyance, frustration, tiredness, sleep disturbances, daily course disturbances and lack of performance. At present, there is much debate about how sound can affect human health and well-being. Stress is hypothetically to play an imperative role and can be seen as an effect of the evaluation of sound or as a coping reaction of the body (fight–flight) and so called as physiologic reflexes.

To understand and investigate similar dimension we need to reflect back on galvanic skin resistance and their role in our daily lives. Psych-physiological constraints are receptive to numerous emotional states including pain, annoyance, anger, shock and repulsiveness. An experimental setting is extensively used to investigate both affective and effective responses through physiological measures with a variety of stimuli in different acoustic frequency modalities. Additionally, researchers have made attempts to identify and explore different physiological changes due to arousal evoking stimuli with different amplitude and acoustic modalities. Nevertheless, to get in-depth understanding about the physiological variation numerous attempts have also been made to investigate psycho-physiological parameters through diverse procedures. Some acquire sensitivity into consideration while others used arousal and acoustic evoking stimuli (Lang, Bradley & Cuthbert 1997). In other studies, it was found that respiration and electro dermal activity increases, while heart rates decelerate after the appearance of stimulus (Gomez, Dawson et al., 2007). Other stated that unlikable acoustic stimuli caused larger falls in heart rate, while more pleasing sound stimuli resulted in bigger rises in respiratory rate. However, the sound stimuli used in various studies are steady-state sounds and only lasted for small time periods ranging from 4 to 30s; therefore, the influence of acoustic stimuli on physiological responses are still uncertain for practical situations with longer durations of sound disclosure (Hume and Ahtamad 2013).

The skin has electric properties that can change relatively quickly and are closely related to the psychological process (Carlson and Carlson, 2012). These changes in the skin's conductance and electro dermal activity (Boucsein, 2012) are related to the variations in the eccrine sweating. Sweat act like an electrolyte. As the sweating increases, the skin pores start filling with the sweat making the skin more conductive.

After finding an association between sound exposure and health issues the WHO proposed guidelines and precautions on sound levels in environment to avoid negative and damaging effect on health. Additionally, according to Basner et al. their research found a positive and close relationship between mounting sound levels and the risk of hypertension, strokes and ischaemic heart diseases including myocardial infarction.

Significant association was found between subjective reactions and to sound and frequency of antihypertensive treatment in the control area. Neus*et al.* demonstrated that sound sensitive participants annoyed by road traffic showed higher increases of blood pressure. In addition, Bjork *et al.* study recently showed that in annoyed participants from road traffic sound, there is significant relationship between average sound level and treatment for arterial hypertension in the last 12 months (P=0.02)

Galvanic Skin Response (GSR) is a non-interfering and easy to capture physiological signal, which is being discovered for the emotion sensing. Human skin is a good conductor of electricity and when a weak electrical current is drop-ship to the skin, changes in the skin's transference of that signal can be measured. GSR is a method of modifiable the internal physical process by giving a biofeedback, which is effective in the treatment of phobias, anxiety, and to increase the relaxation process of the subject during the hypnosis (Pradeep et al., 2008). Blood Volume Pulse is the phasic variation in the blood volume with each heart rate, heartbeat, and heart rate variability (HRV) (Chambers et al., 2005).

The aim of this research was to examine the effect of sound on psycho-physiological skin conductance under controlled and experimental conditions.

METHODOLOGY
Participants
The sample of the present study was selected using the judgmental sampling from post graduate (PG) students of a central university. The sample size of the study comprised 21 students with the age ranges from 20 to 25 years and their mean age was 22.50 years. In terms of gender, both male and female represented the sample and of 7 and 15 respectively. The inclusion criterion was voluntarily willingness of students in the experiment. Participants those who could not complete all the measurements/recordings were excluded too.

Experimental design and Stimuli
In the present study, both fleeting and steady-state sound were used as stimuli. The inbuilt sound of GSR was used as stimulus which represented the transient sound, consisted of real and standard impact sound induced by volume decibel up to 10 db through headphone for audio feedback interchangeably. The volume, balance and level controls at minimum position and feedback gain control at maximum position. Moreover, the sound stimulus was used on different sensitivity level at 2, 5 and 10 in relation to volume decibel. By means of the recordings, all the sound stimuli were abridged to have the duration of 10min.In addition the Actual and Basel value was also recorded through rating display as skin k-Ohms at initial phase of the experiment.

The duration for each session lasted for 50 minutes to enhance our understanding about the variations of the physiological responses over time. Keeping in mind that level of sensitivity in relation to volume decibel type might affect the participant's physiological parameters. The sound pressure increases as the volume decibel increases accordingly. Throughout the experiment each subject took part in two stages with different sound level and other sources to access physiological parameters. The sound exposures for 48 minutes was incessant and were spaced at equal intervals of 30 seconds silent baselines and presented randomly in order to avoid any possible order effect. However, 2 minutes were used for evaluation of rating display in k-ohms with 30seconds in each interval of changing the volume decibel.

Psycho-physiological measurements
Galvanic skin resistance was measured for physiological assessment with Medicaid GSR Biofeedback Biotrainer GBF-2000. A small amount of current so small that it cannot be felt is passed across an area of skin. The resistance to the flow decreases i.e. conductance increases as the person becomes more aroused and alert. Two metal electrodes were tied over the pulp of index finger tips after cleaning with surgical spirit. The basal skin resistance was recorded. Then, the subjects were asked to relax.

Procedure
The subjects were asked to avoid staying up late and to avoid drinking any caffeinated drinks on the day of the experiment. All the electrodes were attached to the subject's body once the subject finished reading the instruction sheet regarding the experiment and gave their consent to participate. The subject was then helped to be seated comfortably on a chair. After briefing the experiment, their blood pressure, pulse rate and oxygen consumption were put on record. Later, the electrodes were placed on the non-dominant hand, so the

participants can write or handle a computer, if required. Before attaching the electrodes, the locations of electrode placement was cleaned up with jelly otherwise the residue could prevent the electrodes from sticking to the skin as well as prevent the electrolyte gel from establishing an electrical connection, which might result in a poor skin conductance signal. And then the electrodes put on the index and middle finger. After the experiment was finished, the researcher disconnected the participant from the devices and debriefs the participant about the true purpose of the research. Finally, the subject was thanked for his/her participation and was asked to leave the lab.

OBJECTIVES

Following objectives for proposed research work were considered practically and theoretically viable to examine under control and experimental condition.

1. To study the difference between control and experimental conditions on skin conductance among PG students.

2. To study the difference between initial and experimental condition on skin conductance among PG students.

3. To study the difference between basal and experimental condition on skin conductance among PG students.

4. To study the correlation between control and experimental conditions on skin conductance among PG students.

HYPOTHESES

After pursuing and reviewing large number of research studies and substantiating theoretical

paradigm, proposed variables identified specific direction and are related to each other.

Therefore, it was decided to frame alternate hypotheses for present piece of research work.

1. There will be difference between control and experimental conditions on skin conductance among PG students.

2. There will be difference between initial and experimental condition on skin conductance among PG students.

3. There will be difference between basal and experimental condition on skin conductance of PG students.

STATISTICAL ANALYSIS

The descriptive statistics, such as minimum, maximum, mean and standard deviation was examined for continuous variables under study. Before-after comparisons on galvanic skin resistance were made in the interest of getting a better understanding of the directions of the effect. Paired t-test was used to find out the mean difference between two dependent samples. Whereas, One-way analysis of variance (ANOVA) with Tukey multiple comparison test was used to find out the mean differences among different levels of sound. The analysis was done with the help of SPSS 25.

RESULTS

In this study, we compared difference between test variables viz. skin conductance, initial/basal, final values and blood pressure based on test variables and results are shown, discussed in following paragraphs.

Table-1: Mean Difference in Control and Experimental conditions of Skin Conductance

Skin Conductance	Mean	N	Std. Deviation	Std. Error Mean	t	p	Cohen's d
Control	260.81	21	120.99	26.40	2.68	0.014	0.59
Experimental	328.67	21	124.19	27.10			

Table 1, showed that there was a significant increase in skin conductance in experimental condition (M =328.67, SD = 124.19) in comparison to control condition (M = 260.81, SD = 120.99). An independent samples t-test found the difference between means significant t (21) = 2.68, at p < 0.01 (one-tailed) levels of significance. Together this suggests that sound affects the skin conductance because the experimental conditions significantly differ when compared with control conditions. The hypothesis HA1 is supported. The effect size values of *Cohen d* when ranges from 0.50 to 0.80 and in our case it is 0.59. It can be inferred that the difference between means between control and experimental conditions for skin conductance is meaningfully large and independent of whether the difference is statistically significant.

Table-2: Mean Difference between Initial and Final stage of Skin Conductance

Skin Conductance	Mean	N	Std. Deviation	Std. Error Mean	t	p	Cohen's d
Initial	266.05	21	120.57	26.310	2.57	0.02	0.56
Final	328.67	21	124.19	27.099			

Table 2, showed that there was a significant increase in skin conductance in experimental condition (M =328.67, SD = 124.19) in comparison to initial condition (M = 266.05, SD = 120.57). Paired samples t-test found the difference between means significant (21) = 2.57, p < 0.02 (one-tailed). Together this suggests that sound affects the skin conductance because the final experimental condition significantly differs when compared with initial conditions. *The hypothesis HA2 is supported.* It is important to notice that the so-called "skin resistance" would not only have a big change in some pathological or unusual physiological states, but have fluctuations at various levels. The effect size values of *Cohen d* when ranges from 0.50 to 0.80 and in our case it is 0.56. It can be inferred that the difference between means between control and experimental conditions for skin conductance is meaningfully large and independent of whether the difference is statistically significant.

Table-3: Difference between means in basal and experimental conditions of Skin conductance

Skin Conductance	Mean	N	Std. Deviation	Std. Error Mean	t	p	Cohen's d
Basal	277.38	21	123.43	26.933	2.06	0.05	0.45
Final	328.67	21	124.19	27.099			

Table 3, showed that there was a significant increase in skin conductance in final experimental condition (M =328.67, SD = 124.19) than in basal condition (M = 277.38, SD = 123.43). An independent samples t-test shows the difference between means significant t(21) = 2.06, p < 0.05 (one-tailed). Together this suggests that sound affects the skin conductance because the final experimental condition significantly differs when compared with basal condition supporting our hypothesis.*. The hypothesis HA3 is supported.* The effect size values of *Cohen d* when ranges from 0.20 to 0.50 and in our case it is 0.45. It can be inferred that the difference between means between basal and final experimental conditions for skin conductance is meaningfully moderate and independent of whether the difference is statistically significant.

The linear correlation between control and experimental conditions on skin conductance was positive (r=0.554) and significant at (p<0.01) level of significance which reflects that there would be correlation between control and experimental conditions on skin conductance. *The hypothesis HA4 is supported.*

The mean of skin conductance on different levels of sound also shows the positive relationship and shown in figure 1.
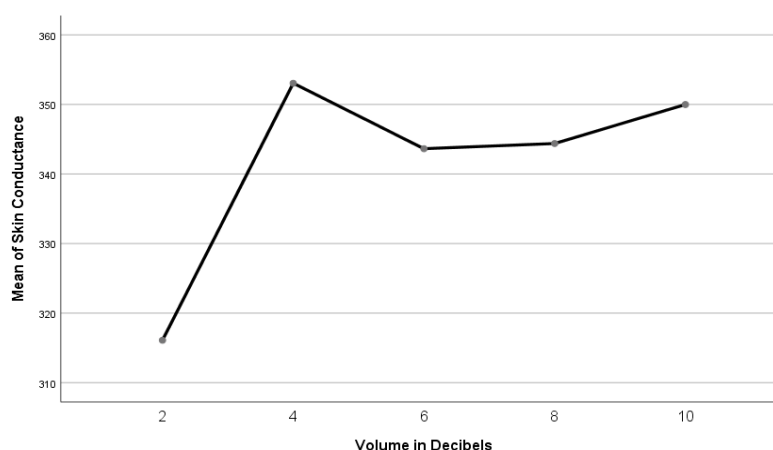
Figure-1: Mean skin conductance with sound

DISCUSSION
In the present study we compared skin conductance under normal (no sound) and experimental (sound of 10db) conditions. See table 1, which displays about the Mean difference in control and experimental conditions of skin conductance the result suggest a significant difference between the two and it can be inferred that when sound is increases so as the skin conductance also increases. Number of studies showed similar pattern and physiological changes when high auditory sound listened by subjects. Our results are supported by the study conducted by Boucsein (2012).

Skin conductance was measured at initial and final levels of experimental condition. We examined, is there tendency of change in skin conductance when auditory sound is high. See table 2, the results reflects the escalating pattern in skin resistance. The experiment confirmed when an individual is continuously exposed to annoying sound and of varying decibels the skin resistance will be of dynamic nature and may have long lasting effect on physiological measurements. Loud sound causes sudden drops in skin resistance, after which resistance recovers gradually during sound stimulation and increases significantly Davis (1932). In the present study the basal value of sound for students was determined and stimulus as sound was given to see the effect of sound on skin conductance. See table 3, these results confirmed the tendency of increasing pattern in skin conductance. GSR on different sensitivity level with different volume decibel for 50 minutes indicates higher arousal in skin resistance compared to basal readings. The findings of our study supported that extra auditory effects are due to activation of autonomic nervous system and hypothalamo-hypophyseal adrenal axis, and the resultant release of catecholamines from adrenal medulla due to sound stress (Saha, 1996).

The findings further reflect that as the exposure of volume decibel amplifies with different acoustic sensitivity caused an increase in different physiological measures of body. Our study also noted and provides further evidence that a positive and highly statistically significant relationship was observed under treatment conditions.The present study demonstrates that there was increase in skin resistance as the sensitivity and sound elevate even up to 10 dBA. This is probably due to the regular emotional and physical stresses in our daily environment and unintentional avoidance of such hazards.

LIMITATIONS

The current study has a number of important limitations in its design and analysis. Obtaining large sample was difficult due to the high demands of study protocol. As a result it was not possible to select a homogeneous sample because of the variability in the subject's baseline characteristics such as heart rate, BP, and respiratory rate. The other limitation that should be noted is that all participants in the experimental studies were students of University, aged 20 to 25 years old, and were considered healthy. The results of this research cannot necessarily be generalized to all populations such as young or elderly groups. The stimulus used in the experimental study may have been affected by age.

FUTURE SUGGESTION

In future studies, it would be valuable to test more arousing types of sound, in order to enhance the possibility to measuring significant differences in physiological parameters. In the same vein, the use of multiple physiological measures, such as neural changes and respiration, in addition to GSR would be relatively simple given the correct equipment and more capable to painting a full picture of participants' physiological reactivity. Another interesting manipulation would be the addition of a second experimental group that experienced a different threshold of sound, such as exposure to an emotional sound etc.

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PREPARING TEACHERS FOR TWENTY FIRST CENTURY: A FEW REFLECTIONS

Dr. Shamim Ahmad[1] and Dr. S D Singh Parihar[2]

Associate Professor[1], Department of Education, Indira Gandhi National Tribal University, Amarkantak
Associate Professor & Head[2], Department of Teacher Education, Ghazipur PG College, Ghazipur

ABSTRACT

This paper strikes the note of preparing teachers for the twenty first century while focusing a more robust and viable system of teacher education in the country. A teacher as considered to be a change agent who, additionally to his most typical role of teaching and testing within the classroom situation, helps and guides others to accumulate information, acquire competencies and imbibe values supported by the students learning designs and interests. What is more important is that competent teachers, more often than not, serve multiple roles in the classroom and beyond. From setting the tone of the classroom, teachers initiate the dialogue through curricular context, introduce their lessons, build a conducive learning environment, uncomplicate the concepts, ideas and different learning contents, question the established procedure and principles, communicate with the students, parents and community, listen, mentor and nurture the scholars to modify them to play wider role, and often, become model for the students. As accessible, flexible and enthusiastic, a teacher engages his students in an objective oriented curricular interaction to mould them into responsible citizens of the country. NCFTE (2009) also reiterates that there is a dire need to critically review the secondary teacher education system in the country. Upgrading teacher education calls for a more participatory approach from the stakeholders, and, thereby, it becomes crucial to prepare and train prospective teachers as per the emerging contexts and values required to face the challenges in facilitating the creative and critical development of the learning groups.

Keywords: ICT; 21st Century; Teacher Education; A Few Reflections.

INTRODUCTION

What are the 21st century teaching skills required for teachers? Are those skills really needed for teachers working in the school system? Why are they important? These are a few questions often discussed among those working in the departments of education, training and educational studies. As practitioners in the field, certain paradigm shifts with regard to the 21st century teaching skills and their rationales have been attempted to examine in the academic investigation. "It is therefore essential to contemplate and develop innovative strategies at different levels of learning to educate the pupils about the world within and without" (Kurhade, M.S., 2019, p.06). Understanding and working on those teaching skills may help to accelerate the pedagogical practices in the school system of the country.

Upgrading teacher education calls for a more participatory approach from the stakeholders. Studies such as that conducted by Kurhade (2019), have shown that our education is geared towards teaching and testing knowledge at every level as opposed to teaching skills. In the context, there is a dire need to review the system of preparing teacher education in order to updgrade and strengthen the professional approach to teacher education. "The 21st century teacher looks forward to the future and are aware of the ever-changing trends in technology keeping in tune of what the future may bring to education" (Cox, J., 2017, p.01).

What has Changed?

In the recent and thorough curriculum framework on Indian teacher education NCFTE (2009) reiterates, as others, that there is a dire need to critically review the secondary teacher education system (NCFTE, 2009, p.10). Teachers through varied teaching skills cause learning in the desirable direction. According to Wikipedia, a teacher is a person who helps other to acquire knowledge, competences and values (Wikipedia, 2019, p.01). The fact to which pointed attention needs to be drawn is that teachers are the most important component of educational institution. Thereby, it becomes crucial to prepare and train the prospective teachers as per the emerging contexts and values required to face the challenges in facilitating the creative and critical development of the learning groups.

India's current education system is more focused on extending learning opportunities catering to the three cardinal principles of education i.e. access, equity and quality. However, the chief responsibility lies with the teacher to transact the curriculum in tune with the 21st century required skills, knowledge and attitude. Today's teachers need to adapt to the constantly changing learning needs of the learners who are living in extremely fast paced world with a:

- Greater diversity,

- Tremendous opportunities and risks,

- Increased chasm between the communities,

- Digital divide

- Education driven by technology and innovation

There is large volume of published studies describing today's teachers, students and other learning groups who live in a world that is extremely fast paced, constantly inconsistent, increasingly diverse and more importantly technologically driven. In the context, both teachers and students have great advantages as they have more powerful teaching learning tools, devices and applications at their disposal which did not exist before. The 21st century technology and technology enabled resources are an opportunity for teachers as well to shoulder their responsibility effectively, efficiently and expeditiously.

Teachers' Multiple Roles

From the larger perspective, a teacher is a person who teaches in a school, college, university or any other educational institution. In the context, the most common role performed by a teacher is to teach the students in the classroom. A teacher is someone who, in addition to his most common role of teaching and testing in the classroom, helps and guides others to seek knowledge, acquire competencies and required values based on their learning styles and interests. "However, perhaps no other profession demands the sort of intimate and consistent engagement with the minds and hearts of young children, while at the same time also being responsible to ensure that they master literacy, numeracy, community roles and life skills" (Luthra, S. & Lahiri, M.S., 2014, p.01). Furthermore, competent teachers serve multiple roles both within and outside classroom situations, a few of them are outlined below:

- Teachers primarily set the tone of their classrooms,

- Teachers initiate the dialogue through curricular context,

- Teachers introduce their lessons as per the needs and requirements of the class,

- Teachers build a warm and conducive learning environment,

- Teachers uncomplicate the curricular concepts and other learning contents,

- Teachers question the established procedure and principles,

- Teachers communicate with the students, parents and community as and when required,

- Teachers motivate and inspire their students,

- Teachers listen and look for signs of trouble in the students,

- Teachers mentor and nurture the students to enable them to play wider role in the society,

- Teachers usually stick to the teaching behavior,

- Teachers improves students' learning through feedback mechanisms,

- Teachers, often, become role model for the students,

As active, accessible and enthusiastic, a teacher engages his students in an objective oriented curricular interaction to mould them into responsible citizens of the country. Based on Mandela's idea that "Education is the most powerful weapon which you can use to change the world" today's teachers need to have a framework and dream for an India ready to meet the challenges and opportunities of the present and future through education.

At the turn of the 21st century, teachers are required to meet the challenges and opportunities of the emerging scenario. In this connection, teachers are expected to move beyond the paper and pen, and chalk and talk method in the process of instruction. Rather, they are supposed to be more learners centric through collaboration, communication, creativity and critical thinking of students. They need to focus more on the blended approach utilizing the traditional as well as alternative way of teaching as and when required. In order to induce performance by the students, teachers make use of role play, action research, seminar presentation, discussion, group reporting etc. Students, now a days, are required to embrace the 21st century knowledge, skills and attitudes, while teachers are expected to use new technology and varied resources to maximize the effects of their teaching learning process.

Curriculum Framework for Teacher Preparation

Teachers, as professionals in most part, play multiple roles in order to bring changes in the students' behavior in desirable direction. Simply, from setting tone of the classroom, teachers play multiple roles i.e. communicator, organizer, manager, course developer, curriculum designer, learning facilitator, mentor, web designer, presenter etc. So, in a sense, the larger perception about teachers' role has been a limited one as teaching and testing students based on a fixed curriculum.

Curriculum framework is an important element in the preparation of teacher education. "A teacher needs to be prepared in relation to the needs and demands arising in the school context, to engage with questions of school knowledge, the learner and the learning process" (NCFTE, 2009,p.02).

It has been suggested by researchers working in the curricular areas of teacher education that to develop the teachers for the 21st century, one needs to focus primarily on the:

1. Core subject and content knowledge,

2. Pedagogical skills and practices,

3. Learning tools and resources, and

4. Assessment strategies for improving learning.

The areas for exhaustive preparation of secondary teachers are also highlighted as the following:
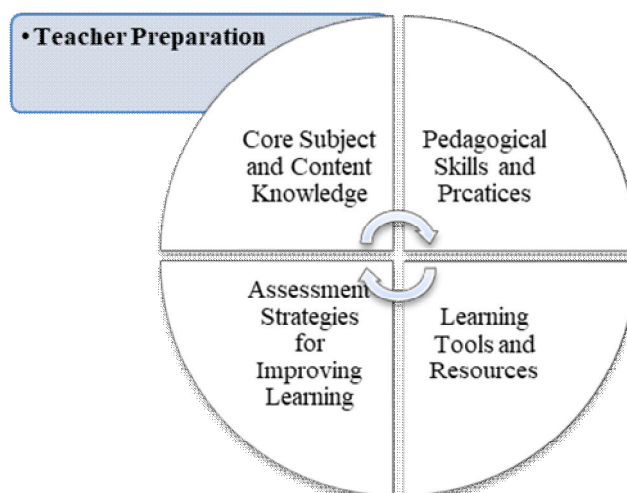
Figure-1: Teacher Preparation

As mentioned in figure 1, core subject is a compulsory component based on the knowledge and understanding of the content of specific subject and discipline. This may refer to the subjects such as languages, mathematics, sciences, social sciences etc.

Pedagogical skills and practices are also essential components and in order to understand the complexities of teaching and learning hands on experiences are shared and practiced.

Learning tools and resources refer to those new technology mediated learning and materials used by the students to work through various concepts while creating, performing and responding to learning designs.

Assessment strategies need to be considered and applied keeping in view to the improvement of the learners and learning.

It is also important to focus on the 21st century teachers and skills required as per the National Council for Teacher Education Curriculum Framework 2014 based on the:

1. Perspectives in education,

2. Curriculum and pedagogic studies, and

3. Engagement with the field.

The three cardinal areas as curriculum framework for secondary level teachers as proposed by the country's highest teacher education regulatory authority i.e. NCTE are also outlined below:
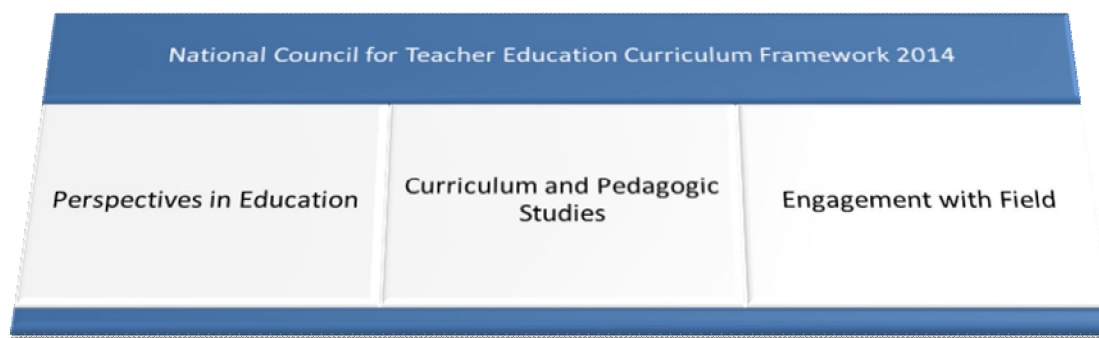
Figure-2: NCTE Curriculum Framework 2014

The three cardinal areas as suggested by NCTE such as understanding perspectives in education, curriculum and pedagogic studies and more importantly prospective teachers' engagement with the field for the hands on experiences are the core identified areas for preparing competent secondary teachers in the country. The 21st century teachers would, in addition to the above, be required to adopt and adapt with the changes in the way knowledge is created, disseminated and applied across disciplines. This can be achieved when the educational institutions could do the following:

- Outlining the institutional policy for a robust teacher education programme,

- Facilitating the prospective teachers through viable support mechanisms,

- Extending online learning facilities for learners,

- Designing and developing learning modules to train and develop the prospective teachers and in service teachers,

- Imparting teacher education in tune with the emerging contexts and values,

- Making arrangements for students and teachers exchange programme for varied reasons,

- Planning teachers' assessment through teacher's self appraisals, peer appraisal and learners' feedback mechanism,

- Strengthening the remedial teaching activities,

- Adding professionalism in the preparation of secondary teachers, and

- Organizing teachers' professional development programme about innovations and best practices,

At the turn of the 21st century, a number of steps and initiatives have been taken so far as reforms in education are concerned, but still more efforts are needed to achieve the goals of a humane and robust education system in the country.

Tipping Points for Twenty First Century Teachers

The University Education Commission reports that "People in this country have been slow to recognise that Education is a profession for which intensive preparation is necessary as it is in any other profession" (University Education Commission, 1948-49, p.183). A large and growing body of literature suggests that people in India have, of late, recognized the teaching as a profession which was earlier regarded as a sacred activity. To be effective in the emerging educational scenario, a teacher must have:

- A shared vision of 21st century education system,

- An engaging personality with attractive teaching style,

- Global awareness,

- Adequate pedagogic skills,

- Learning and innovative skills,

- Adaptability to the constantly changing learning environment,

- Classroom management skills,

- Rapport with the diverse learning groups,

- Communication with parent and community

- Information and communication technology skills,

- Knowledge of curriculum and standards,

- Knowledge of assessment strategies for improved learning performance, and

- Continuous professional development.

It is also interesting to note that the adequate pedagogical skills and practices are required to understand the complexities of teaching and learning. Accordingly, hands on experiences which are relevant to the emerging contexts equally need to be shared and practiced to maximize the learning effects.

CONCLUDING REMARKS
On the whole, teachers make use of teaching and learning tools and resources embedded with technology to meet the challenges while creating, performing and responding to the emergent teaching learning designs. A number of steps and initiatives have been taken as part of reforms in education, but still more efforts are needed to achieve the goals of a humane and robust education system in the country. What is more important is that competent teachers, more often than not, serve multiple roles in the classroom and beyond. Given the curriculum framework and other guidelines, it becomes crucial to prepare and train prospective teachers as per the emerging contexts and values required to face the challenges in facilitating the creative and critical development of the learning groups.

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STABILITY ANALYSIS OF CROP DUE TO SOIL AND WATER

Nita H. Shah, Ekta N. Jayswal, Moksha H. Satia and Foram A. Thakkar
Department of Mathematics, Gujarat University, Ahmedabad

ABSTRACT
Crop modeling is a decision making tool for agriculture. Decision making depends on use of latest techniques and equipment. Almost 70% of water resources are used by agriculture sector. The water can be polluted or clean. This polluted water is recycled to use as clean water. The proposed model considers both types of water constraints. The dynamical system of non- linear differential equation has been formulated dealing with five compartments viz. water volume, clean water volume, polluted water volume, soil fertility and crop. The threshold value is calculated which gives crop dependency. One should not waste water as both shortage and excess of water affect the growth and development of plant, directly and consequently its yield. Stability analysis showed that the approach is effective for the crop by its derived conditions. Bifurcation and sensitivity analysis are worked out. Control as a treatment has been put on polluted water to improve fertility. Crop is observed through numerical simulation which precisely predicts that soil and clean water play a vital role in sustaining life on the planet.

Keywords: Mathematical model, Threshold, Stability analysis, Bifurcation, Control

1. INTRODUCTION

Human activities either it is of domestic, agricultural or industrial have an impact on water. Water is absolute requirement for all living organisms. It contributes directly or indirectly in their all metabolic processes. It is considered as a universal solvent. One study has proved that agriculture sector is the single largest user of clean water. From the soil it helps as transport medium for mineral nutrients to crop. Crop need huge amount of better water quality during their life. Water helps in photosynthesis, translocation, respiration, absorption and many more other processes for crops. On the basis of nature, it is categorized in polluted water and clean water. Out of these polluted water occurred by three reasons: surface water pollution, ground water pollution, arsenic contamination of ground water. It may remove essential nutrients and effects negatively for proper crop growth. Government has developed several techniques to recycle this polluted water. So that this improved water quality can be used in various ways. Using this both the water volume in soil, we have established two approaches for crop growth. Soil can be thought of as the ecosystem basis. Soil depletion occurs when the conditions which support soil's fertility are not maintained maybe causes poor crop. Physical properties of soil directly impact crop. It gets gradually saturated with required water. For any crop productivity, better soil fertility and clean water are necessary one.

Pathak *et al.*(2015) has published a book on state of Indian agriculture water. Feddes *et al.*(1988) has done work on simulation of model named modelling soil water dynamics in the unsaturated zone- state of the art. Using biomass into roots for crop, Williams *et al.* (1989) developed model on the EPIC crop growth model. Brouwer *et al.* (1985) have written in chapter on irrigation water management: training manual no. 1 - introduction to irrigation which gave theory on physical characteristics of soil texture and water. Computer simulation in plant breeding (2012) model is analyzed using computer simulation and genetic mapping by Li *et al.* One model Sala *et al.* (2015) has established on mathematical model for determining the optimal doses of mineral fertilizers for wheat crops, using Mitscherlich - type model. Using multi – objective fuzzy robust programming Tan *et al.* (2017) gave paper on optimal use of agricultural water and land resources through reconfiguring crop planting structure under socioeconomic and ecological objectives. Xiang *et al.* (2013) had used linear optimization to illustrate, dynamic modeling and simulation of water environment management with a focus on water recycling. Recently, Shah *et al.* (2018) mathematical modeling for recycling of sewage water with control theory and other paper has been on bifurcation and stability analysis for environmental pollutants through three-layered population and rain.

Formulation of mathematical model is prepared in section 2. The system of dynamical behavior is shown in transmission diagram with its derived equations. In section 3, stability analysis for two equilibrium points is noted. Bifurcation in consider of threshold value is simulated in section 4. Control theory in section 5, shows the benefit on crop. And for the conclusion numerical simulation and sensitivity analysis is observed for validated data.

2. MATHEMATICAL MODELING

In the society, we are living with environmental resources like water (W), soil (S) etc. Using these resources as compartment we have developed this model. Water quality can be either clean water (W_C) or polluted water (W_P). The treatment in terms of control (u_1) should be given for converting polluted water into clean one. Density of fertile soil affected by both types of water volume finally resulted into crop (C).

Table-1: Notations, Description and Parametric values

Notation	Description	Parametric values
B	The input rate of water volume	0.75
β_1	Increases rate of clean water volume	0.40
β_2	Increases rate of polluted water volume	0.02
γ_1	The rate at which clean water becomes polluted water	0.30
γ_2	The rate at which polluted water becomes clean water	0.60
δ_1	The clean water absorption rate of soil	0.80
δ_2	The polluted water absorption rate of soil	0.30
ε	The rate of crop due to soil fertility	0.15
η	The rate of crop due to clean water volume	0.40
μ	Wastage rate of variable from respective compartment	0.30
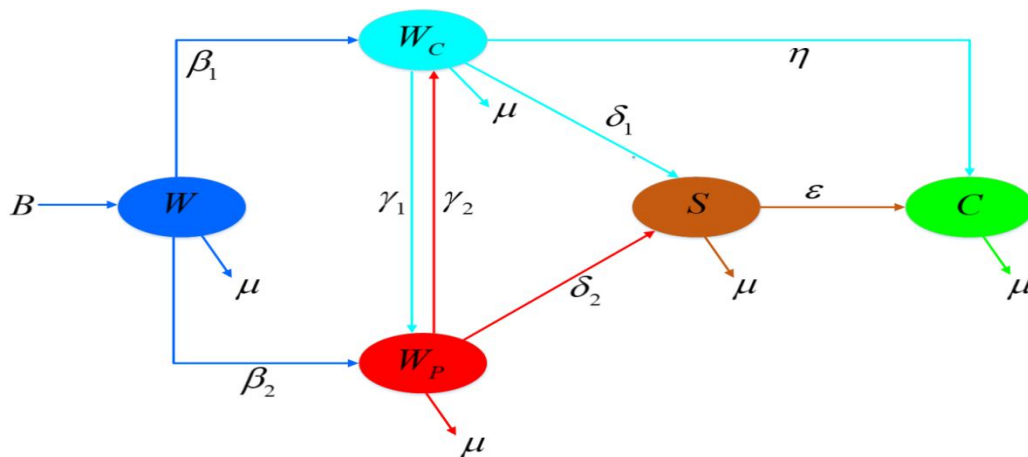
Figure-1: Transmission diagram

Using all the parameters mentioned in Table 1 above diagram has been framed; for this diagram system of non-linear differential equations is gives as follows:

$$\frac{dW}{dt} = B - \beta_1 W W_C - \beta_2 W W_P - \mu W$$

$$\frac{dW_C}{dt} = \beta_1 W W_C - \gamma_1 W_C + \gamma_2 W_P - \delta_1 W_C - \eta W_C - \mu W_C + u_1 W_P$$

$$\frac{dW_P}{dt} = \beta_2 W W_P + \gamma_1 W_C - \gamma_2 W_P - \delta_2 W_P - \mu W_P - u_1 W_P$$

(1)

$$\frac{dS}{dt} = \delta_1 W_C + \delta_2 W_P - \varepsilon S - \mu S$$

$$\frac{dC}{dt} = \eta W_C + \varepsilon S - \mu C$$

where, $W > 0$; $W_C, W_P, S, C \geq 0$

Accumulating the differential equations of system (1) we have,

$$\frac{d}{dt}\left(W + W_C + W_P + S + C\right) = B - \mu W - \mu W_C - \mu W_P - \mu S - \mu C$$

$$= B - \mu(W + W_C + W_P + S + C) \geq 0$$

which implies that $\limsup_{t\to\infty} (W + W_C + W_P + S + C) \leq \dfrac{B}{\mu}$

Therefore, the feasible region of the model is

$$\Lambda = \left\{ (W, W_C, W_P, S, C) \in R^4 : W + W_C + W_P + S + C \leq \frac{B}{\mu} \right\}.$$

The equilibrium point of the transmission of model is $E_0 = \left(\dfrac{B}{\mu}, 0, 0, 0, 0 \right)$.

Next, the stability of model is examined by calculating basic reproduction number R_0 by using next generation matrix method.

where $F(X) =$ is for the rate of appearance of new individual in component and

$V(X) =$ is for the rate of transfer of water which is given by

$$F(X) = \begin{bmatrix} \beta_1 W W_C \\ \beta_2 W W_P \\ 0 \\ 0 \\ 0 \end{bmatrix} \text{ and } V(X) = \begin{bmatrix} \gamma_1 W_C - \gamma_2 W_P + \delta_1 W_C + \eta W_C + \mu W_C \\ -\gamma_1 W_C + \gamma_2 W_P + \delta_2 W_P + \mu W_P \\ -\delta_1 W_C - \delta_2 W_P + \varepsilon S + \mu S \\ -\eta W_C - \varepsilon S + \mu C \\ -B + \beta_1 W W_C + \beta_2 W W_P + \mu W \end{bmatrix}$$

Now, $DF(E_0) = \begin{bmatrix} f & 0 \\ 0 & 0 \end{bmatrix}$ and $DV(E_0) = \begin{bmatrix} v & 0 \\ J_1 & J_2 \end{bmatrix}$

where, f and v are 5×5 matrices defined as

$$f = \left[\frac{\partial F_i(E_0)}{\partial X_j} \right] \text{ and } v = \left[\frac{\partial V_i(E_0)}{\partial X_j} \right]$$

Finding f and v, we get

$$f = \begin{bmatrix} \dfrac{\beta_1 B}{\mu} & 0 & 0 & 0 & 0 \\ 0 & \dfrac{\beta_2 B}{\mu} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \text{ and } v = \begin{bmatrix} \gamma_1 + \delta_1 + \eta + \mu & -\gamma_2 & 0 & 0 & 0 \\ -\gamma_1 & \gamma_2 + \delta_2 + \mu & 0 & 0 & 0 \\ -\delta_1 & -\delta_2 & \varepsilon + \mu & 0 & 0 \\ \eta & 0 & -\varepsilon & \mu & 0 \\ \dfrac{\beta_1 B}{\mu} & \dfrac{\beta_2 B}{\mu} & 0 & 0 & \mu \end{bmatrix}$$

where, v is non-singular matrix.

Hence, the mathematical expression of basic reproduction number R_0 is given as follows [2]:

$R_0 = $ Spectral radius of matrix fv^{-1}

$$\therefore R_0 = \frac{\beta_1 B(\gamma_2 + \delta_2 + \mu) + \beta_2 B(\gamma_1 + \delta_1 + \eta + \mu)}{\mu(\delta_1(\gamma_2 + \delta_2 + \mu) + \delta_2(\gamma_1 + \eta + \mu) + (\eta + \mu)(\gamma_2 + \mu) + \mu\gamma_1)} \tag{2}$$

3. STABILITY

Two equilibrium points are carried out. Local stability and global stability for both points are derived in this section.

3.1 Local Stability

Local stability is established by using Jacobian matrix for both the equilibrium points. Jacobian matrix is given by,

$$J = \begin{bmatrix} -\beta_1 W_C - \beta_2 W_P - \mu & -\beta_1 W & -\beta_2 W & 0 & 0 \\ \beta_1 W_C & \beta_1 W - \gamma_1 - \delta_1 - \eta - \mu & \gamma_2 & 0 & 0 \\ \beta_2 W_P & \gamma_1 & \beta_2 W - \gamma_2 - \delta_2 - \mu & 0 & 0 \\ 0 & \delta_1 & \delta_2 & -\varepsilon - \mu & 0 \\ 0 & \eta & 0 & \varepsilon & -\mu \end{bmatrix}$$

Theorem 3.1.1: The unique equilibrium point $E_0\left(\dfrac{B}{\mu}, 0, 0, 0, 0\right)$ of model is asymptotically locally stable with conditions.

Proof: The Jacobian matrix at $E_0\left(\dfrac{B}{\mu}, 0, 0, 0, 0\right)$ of the model is as given below:

$$J_0 = \begin{bmatrix} -\mu & \dfrac{-\beta_1 B}{\mu} & \dfrac{-\beta_2 B}{\mu} & 0 & 0 \\ 0 & -x_1 & \gamma_2 & 0 & 0 \\ 0 & \gamma_1 & -x_2 & 0 & 0 \\ 0 & \delta_1 & \delta_2 & -\varepsilon - \mu & 0 \\ 0 & \eta & 0 & \varepsilon & -\mu \end{bmatrix}$$

where,

$$x_1 = -\frac{\beta_1 B}{\mu} + \gamma_1 + \delta_1 + \eta + \mu$$

$$x_2 = -\frac{\beta_2 B}{\mu} + \gamma_2 + \delta_2 + \mu$$

Above Jacobian J_0 has eigenvalues,

$$\omega_1 = -\varepsilon - \mu$$

$$\omega_2 = -\frac{1}{2}x_1 - \frac{1}{2}x_2 + \frac{1}{2}\sqrt{4\gamma_1\gamma_2 + x_1^2 + 2x_1 x_2 + x_2^2}$$

$$\omega_3 = -\frac{1}{2}x_1 - \frac{1}{2}x_2 - \frac{1}{2}\sqrt{4\gamma_1\gamma_2 + x_1^2 - 2x_1 x_2 + x_2^2}$$

$$\omega_4 = -\mu$$

$$\omega_5 = -\mu$$

Each eigenvalues of above matrix are negative except ω_2 as its all parameters will take positive values. Therefore, we derived conditions for a model to be stable as follows:

(i) $\gamma_1 + \delta_1 + \eta + \mu > \dfrac{B\beta_1}{\mu}$

(ii) $\gamma_2 + \delta_2 + \mu > \dfrac{B\beta_2}{\mu}$

Theorem 3.1.2: The endemic equilibrium point $E^*(W^*, W_C^*, W_P^*, S^*, C^*)$ of model is asymptotically locally stable with conditions.

Proof: Further, we check the local stability of $E^*(W^*, W_C^*, W_P^*, S^*, C^*)$ using Jacobian matrix.

where,

$$W^* = RootOf\,(\beta_1\beta_2 \_ Z^2 + (-\beta_1(\delta_2 + \gamma_2 + \mu) - \beta_2(\delta_1 + \gamma_1 + \eta + \mu))\_Z + \delta_1(\delta_2 + \gamma_2 + \mu)$$
$$+ (\gamma_2 + \mu)(\eta + \mu) + \gamma_1\mu)$$

Here we assume $W^* = r$,

$$W_C^* = -\frac{\gamma_2(-\mu r + B)}{\beta_1 r(\delta_2 + \mu) - \delta_1(\delta_2 + \gamma_2 + \mu) - \delta_2(\mu + \eta + \gamma_1) - (\mu + \eta)(\gamma_2 + \mu) - \gamma_1\mu}$$

$$W_P^* = \frac{\begin{array}{c}\mu^2(\mu - r\beta_1)(\delta_1 + \delta_2 + \eta + \gamma_1 + \gamma_2) - B\beta_2(\delta_1^2 + \eta^2) + \delta_1^2\mu(\delta_2 + \gamma_2) + (\mu^2(\delta_1 + \delta_2) + \delta_1(\mu\delta_2 - B\beta_1)) \\ (2\eta + \gamma_1) + \eta\mu(\eta(\delta_1 + \delta_2) + \gamma_1) + \mu^4 + \mu^2((\eta^2 + \delta_1^2) + \mu(\eta + \delta_1)) + B(\beta_1\gamma_1(\delta_2 + \mu) - \beta_1\eta\gamma_1) + 2\eta\mu \\ (\delta_1\gamma_2 + \delta_2\gamma_1) - 2B\beta_2\mu(\delta_1 + \eta + \gamma_1 + \mu) + \beta_1 r(B\beta_2(\delta_1 + \eta) - \delta_2\mu(\eta + \gamma_1)) + \mu(B\beta_2 - \mu^2)\end{array}}{((\beta_1(\delta_2 + \mu) - \beta_2(\delta_1 + \mu + \eta))(\delta_1(\delta_2 + \gamma_2 + \mu) + \delta_2(\eta + \gamma_1 + \mu) + (\eta + \mu)(\gamma_2 + \mu) + \gamma_1\mu))}$$

$$S^* = \frac{\begin{array}{c}\beta_1\delta_2 r(B\beta_2 - \mu(\delta_2 + \gamma_2 + \mu)) + \beta_2\delta_1(\gamma_2\mu r - B(\delta_2 + \gamma_2)) + (\delta_2^2\mu - B\beta_2\delta_2)(\eta + \gamma_1 + \mu) \\ + \delta_2\mu(\delta_1\delta_2 + \gamma_1\mu) + \delta_2\mu(\delta_1 + \eta + \mu)(\gamma_2 + \mu)\end{array}}{\beta_2(\varepsilon + \mu)(\beta_1 r(\delta_2 + \mu) - \delta_1(\delta_2 + \gamma_2 + \mu) - \delta_2(\mu + \eta + \gamma_1) - (\mu + \eta)(\gamma_2 + \mu) - \gamma_1\mu)}$$

$$C^* = \frac{\begin{array}{c}\varepsilon B\beta_1\beta_2\delta_2 r + \varepsilon\delta_2\mu(\delta_2 + \gamma_2 + \mu)(\delta_1 - \beta_1 r) + \beta_2\gamma_2\mu r(\varepsilon(\delta\mu_1 + \eta) + \eta\mu) - B\beta_2\varepsilon(\delta_2(\delta_1 + \gamma_1 + \eta + \mu) \\ + \delta_1\gamma_2 + \eta\gamma_2(1 + \mu)) + \delta_2^2\varepsilon\mu(\gamma_1 + \eta + \mu) + \delta_2\varepsilon\mu(\eta(\gamma_2 + \mu) + \mu(\gamma_1 + \gamma_2 + 1))\end{array}}{\mu\beta_2(\varepsilon + \mu)(\beta_1 r(\delta_2 + \mu) - \delta_1(\delta_2 + \gamma_2 + \mu) - \delta_2(\mu + \eta + \gamma_1) - (\mu + \eta)(\gamma_2 + \mu) - \gamma_1\mu)} \quad \text{The}$$

Jacobian matrix for E^* is given below,

$$J^* = \begin{bmatrix} -x_3 & -\beta_1 W^* & -\beta_2 W^* & 0 & 0 \\ \beta_1 W_C^* & -x_4 & \gamma_2 & 0 & 0 \\ \beta_2 W_P^* & \gamma_1 & -x_5 & 0 & 0 \\ 0 & \delta_1 & \delta_2 & -\varepsilon - \mu & 0 \\ 0 & \eta & 0 & \varepsilon & -\mu \end{bmatrix}$$

$x_3 = \beta_1 W_C^* + \beta_2 W_P^* + \mu$

$x_4 = -\beta_1 W^* + \gamma_1 + \delta_1 + \eta + \mu$

$x_5 = -\beta_2 W^* + \gamma_2 + \delta_2 + \mu$

Characteristic polynomial for this Jacobian matrix is,

$\lambda^5 + a_1\lambda^4 + a_2\lambda^3 + a_3\lambda^2 + a_4\lambda + a_5 = 0$

where a_i's are defined as follows:

$$a_1 = 2\mu + \varepsilon + x_4 + x_5 + x_3$$

$$a_2 = W^* W_C^* \beta_1^2 + W^* W_P^* \beta_2^2 + \varepsilon\mu + (\varepsilon + 2\mu)(x_4 + x_5 + x_3) + x_4 x_5 - \gamma_1 \gamma_2 + \mu^2 + x_5 x_3 + x_4 x_3$$

$$a_3 = W^* (W_C^* (\beta_1^2 (\varepsilon + x_5 + 2\mu) + \beta_1 \beta_2 \gamma_1) + W_P^* (\beta_1 \beta_2 \gamma_2 + \beta_2^2 (\varepsilon + x_4) + 2\beta_2^2 \mu))$$
$$+ (x_4 x_5 - \gamma_1 \gamma_2)(\varepsilon + 2\mu + x_3) + \mu(\varepsilon + \mu)(x_4 + x_5 + x_3) + x_3 (\varepsilon(x_5 + x_4) + x_4 x_5)$$

$$a_4 = W^* (W_C^* \beta_1^2 (\varepsilon(\mu + x_5) + \mu^2) + \beta_1 \beta_2 \varepsilon (W_C^* \gamma_1 + W_P^* \gamma_2) + 2\beta_1 \beta_2 \mu (W_C^* \gamma_1 + W_P^* \gamma_2) + W_P^* \beta_2^2$$
$$(1 + 2\mu x_4)) + (\varepsilon(\mu + x_4) + \mu^2) + (x_4 x_5 - \gamma_1 \gamma_2)(\varepsilon(\mu + x_3) + \mu(\mu + 2x_3)) + \mu x_3 (\varepsilon + \mu)(x_4 + x_5)$$

$$a_5 = \mu(\mu + \varepsilon)(W^* (W_C^* \beta_1^2 x_5 + W_P^* \beta_2^2 x_4 + \beta_1 \beta_2 (W_C^* \gamma_1 + W_P^* \gamma_2)) + x_3 (x_4 x_5 - \gamma_1 \gamma_2))$$

Using Routh - Hurwitz criteria (Routh, E. J. (1877)) for endemic equilibrium point E^*, we have three conditions to be locally asymptotically stable, i.e.

(i) $\gamma_1 + \delta_1 + \eta + \mu > \beta_1 W^*$

(ii) $\gamma_2 + \delta_2 + \mu > \beta_2 W^*$

3.2 Global Stability

In this section, we establish the global stability of E_0 and E^* using Lyapunov function.

Theorem 3.2.1: The unique equilibrium point $E_0 \left(\dfrac{B}{\mu}, 0, 0, 0, 0 \right)$ of model is globally asymptotically stable with conditions.

Proof: Let Lyapunov function be,

$$L(t) = W_C(t) + W_P(t) + S(t) + C(t)$$

$$L'(t) = W_C'(t) + W_P'(t) + S'(t) + C'(t)$$

$$= \beta_1 W W_C - \mu W_C + \beta_2 W W_P - \mu W_P - \mu S - \mu C$$

$$= (\beta_1 W - \mu) W_C + (\beta_2 W - \mu) W_P - \mu(S + C)$$

Hence, by LaSalle's Invariance Principle (La Salle, 1976)

$L'(t) \le 0$ if $\dfrac{B\beta_1}{\mu} - \mu < 0$ and $\dfrac{B\beta_2}{\mu} - \mu < 0.$ One more $L'(t) = 0$ if $W_C = W_P = 0$ and $S + C = 0.$

Thus, we have two conditions that $B\beta_1 < \mu^2$ and $B\beta_2 < \mu^2$ for E_0 to be globally stable.

Theorem 3.2.2: The endemic equilibrium point $E^*(W^*, W_C^*, W_P^*, S^*, C^*)$ of model is globally asymptotically stable.

Proof: Another function for E^* is,

$$L(t) = \frac{1}{2} \left[\left(W - W^* \right) + (W_C - W_C^*) + (W_P - W_P^*) + \left(S - S^* \right) + \left(C - C^* \right) \right]^2$$

Then,

$$L'(t) = \left[\left(W - W^* \right) + (W_C - W_C^*) + (W_P - W_P^*) + \left(S - S^* \right) + \left(C - C^* \right) \right] (W' + W_C' + W_P' + S' + C')$$

$$= \left[\left(W - W^* \right) + (W_C - W_C^*) + (W_P - W_P^*) + \left(S - S^* \right) + \left(C - C^* \right) \right] (B - \mu(W + W_C + W_P + S + C))$$

$$= \left[\left(W - W^* \right) + (W_C - W_C^*) + (W_P - W_P^*) + \left(S - S^* \right) + \left(C - C^* \right) \right] (-\mu \left(W - W^* \right) + (W_C - W_C^*)$$
$$+ (W_P - W_P^*) + (S - S^*) + (C - C^*))$$

$$= -\mu\left[\left(W - W^*\right) + (W_C - W_C^{\ *}) + (W_P - W_P^{\ *}) + \left(S - S^*\right) + \left(C - C^*\right)\right]^2 \le 0$$

Here, we have taken $B = \mu(W^* + W_C^{\ *} + W_P^{\ *} + S^* + C^*)$

Endemic equilibrium point E^* is globally asymptotically stable.

4. BIFURCATION

To analyze the backward bifurcation, cubic water volume compartment should be at least non zero. Solving system (1) we get,

$$F(W^*) = AW^{*2} + BW^* + C = 0 \qquad\qquad (3)$$

where,

$$A = \beta_1\beta_2$$

$$B = -\beta_1(\delta_2 + \gamma_2 + \mu) - \beta_2(\delta_1 + \gamma_1 + \eta + \mu)$$

$$C = \delta_1(\delta_2 + \gamma_2 + \mu) + \delta_2(\eta + \gamma_1 + \mu) + (\eta + \mu)(\gamma_2 + \mu) + \mu\gamma_1$$

The coefficient A must be always positive and C should depend upon the value of R_0, if $R_0 < 1$ then C is positive and if $R_0 > 1$ then C is negative. For $A > 0$, the positive result depends upon the sign of B and C. The equation (3) has two roots; from that one is positive and other is negative for $R_0 > 1$. Now, if $R_0 = 1$ then $C = 0$ and we obtain a non-zero solution of equation (3) as $-\dfrac{B}{A}$ which is positive if and only if $B < 0$. For $B < 0$, there exists a positive interior equilibrium point for $R_0 = 1$ that means the equilibria continuously depends upon R_0, indicating that there exists an interval for R_0 which have two positive equilibria $I_1 = \dfrac{-B - \sqrt{B^2 - 4AC}}{2A}$, $I_2 = \dfrac{-B + \sqrt{B^2 - 4AC}}{2A}$. For, backward bifurcation putting the discriminant $B^2 - 4AC = 0$ and then solving for the critical points of R_0 gives

$$R_C = 1 - \frac{B^2((\beta_1 B - \mu(\delta_1 + \eta + \mu))(\gamma_2 + \delta_2 + \mu) + \beta_2 B(\gamma_1 + \delta_1 + \eta + \mu) - \gamma_1\mu(\delta_2 + \mu))}{4A(-\mu(\delta_1(\gamma_2 + \delta_2 + \mu) + \delta_2(\gamma_1 + \eta + \mu) + \eta(\gamma_2 + \mu) + \mu(\gamma_1 + \gamma_2 + \mu))^2)}$$

If $R_C < R_0$, then $B^2 - 4AC > 0$ and for the point of R_0 backward bifurcation exists such that $R_C < R_0 < 1$ (Khan *et al.* (2014), Wangari *et al.* (2016)).
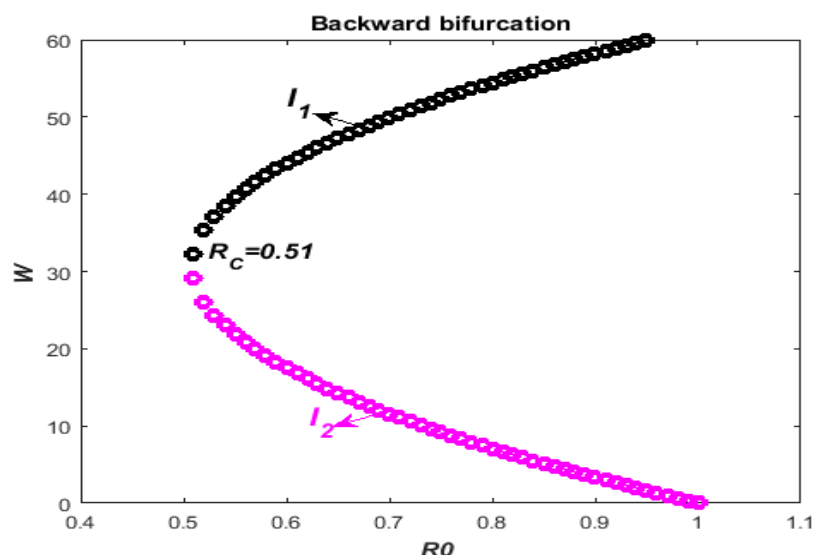
Figure-2: Backward bifurcation for water volume

5. OPTIMAL CONTROL

Objective of model is to control polluted water volume. Therefore, in this section we take an optimal control in terms of treatment given to it which has been converted into clean one. The objective function for mentioned scenario is given by,

$$J(u_i, \Omega) = \int_0^T (A_1 W^2 + A_2 W_C^2 + A_3 W_P^2 + A_4 S^2 + A_5 C^2 + w_1 u_1^2) \, dt \qquad (4)$$

where, Ω denotes set of all compartmental variables, A_1, A_2, A_3, A_4, A_5 denote non-negative weight constants for compartments W, W_C, W_P, S, C respectively and w_1 is weight constants for control variable u_1.

As, the weight parameter w_1 is a constant of the control rate applied on polluted water volume for generating pollutants (u_1), from which the optimal control condition is normalized. u_1 is the control rate for minimizing the polluted water volume from the water volume. Now, we will calculate the values of control variables from $t = 0$ to $t = T$ such that

$$J(u_1) = J(u_1^*, \Omega), u_1 \in \phi$$

where ϕ is a smooth function on the interval $[0,1]$. The optimal control denoted by u_1 is found by accumulating all the integrands of equation (4) using the lower bounds and upper bounds respectively with the results of Fleming and Rishel (2012).

For minimizing the cost function in (4), using the Pontrygin's principle from Boltyanki*et al.* (1986) by constructing Lagrangian function consisting of state equations and adjoint variables $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5$ as follows:

$$L(\Omega, A_i) = A_1 W^2 + A_2 W_C^2 + A_3 W_P^2 + A_4 S^2 + A_5 C^2 + w_1 u_1^2 + \lambda_1 (B - \beta_1 WW_C - \beta_2 WW_P - \mu W) + \lambda_2 (\beta_1 WW_C$$
$$- \gamma_1 W_C + \gamma_2 W_P - \delta_1 W_C - \eta W_C - \mu W_C + u_1 W_P) + \lambda_3 (\beta_2 WW_P + \gamma_1 W_C - \gamma_2 W_P - \delta_2 W_P - \mu W_P - u_1 W_P) \text{ T}$$
$$+ \lambda_4 (\delta_1 W_C + \delta_2 W_P - \varepsilon S - \mu S) + \lambda_5 (\eta W_C + \varepsilon S - \mu C)$$

he partial derivative of the Lagrangian function with respect to each variable of the compartment gives the adjoint equation variables $A_i = (\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$ corresponding to the system which is as follows:

$$\dot{\lambda_1} = -\frac{\partial L}{\partial W} = -2A_1 W + (\lambda_1 - \lambda_2)(\beta_1 W_C + \beta_2 W_P) + \lambda_1 \mu$$

$$\dot{\lambda_2} = -\frac{\partial L}{\partial W_C} = -2A_2 W_C + (\lambda_1 - \lambda_2)\beta_1 W + \gamma_1(\lambda_2 - \lambda_3) + \delta_1(\lambda_2 - \lambda_4) + \eta(\lambda_2 - \lambda_5) + \lambda_2 \mu$$

$$\dot{\lambda_3} = -\frac{\partial L}{\partial W_P} = -2A_3 W_P + (\lambda_1 - \lambda_3)\beta_2 W + (\gamma_2 - u_1)(\lambda_3 - \lambda_2) + \delta_2(\lambda_3 - \lambda_4) + \lambda_3 \mu$$

$$\dot{\lambda_4} = -\frac{\partial L}{\partial S} = -2A_4 S + \varepsilon(\lambda_4 - \lambda_5) + \lambda_4 \mu$$

$$\dot{\lambda_5} = -\frac{\partial L}{\partial C} = -2A_5 C + \lambda_5 \mu$$

The necessary condition for Lagrangian function L to be optimal for control is

$$\dot{u_1} = -\frac{\partial L}{\partial u_1} = -2w_1 u_1 + (\lambda_3 - \lambda_2)W_P = 0$$

Hence, we get

$$u_1 = \frac{W_P(\lambda_3 - \lambda_2)}{2w_1}$$

This gives optimal control condition as

$$u_1^* = max\left(a_1, min\left(b_1, \frac{W_P(\lambda_3 - \lambda_2)}{2w_1} \right) \right)$$

Analytical results for optimal control are calculated numerically in next section.

6. NUMERICAL SIMULATION

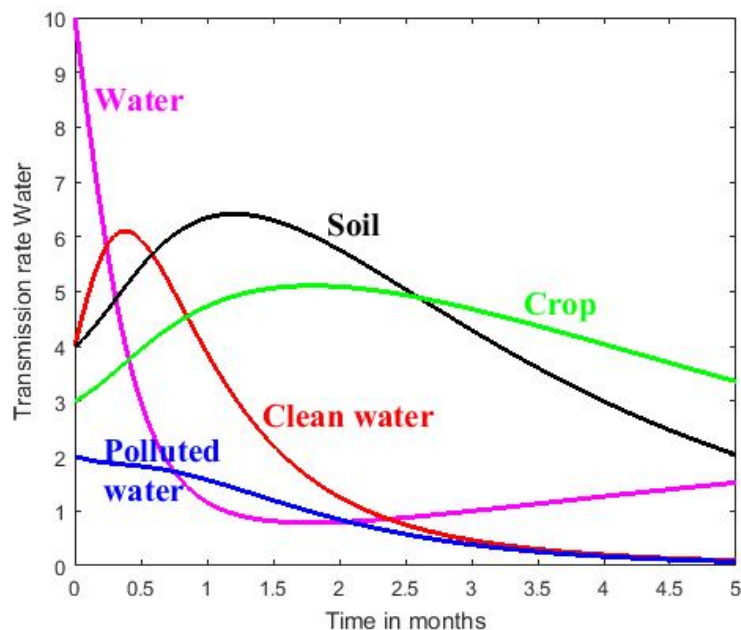In this section, we depict some results from numerical simulation of proposed model.

Figure-3: Transmission of all compartments

We simulate the differential equations given in the system (1) in this figure 3. One can see that approximately after two weeks water is separated into clean water and soil absorbs making soil ready for cropping. After 7.5 weeks, water gets polluted. In the span of three months, clean water changed in polluted water as it comes in contact with soil. Volume of crop is directly proportional to the soil fertility and the clean water. 70% crop is gained when 52% clean water is supplied from main source of water volume. Polluted water volume decreases gradually.
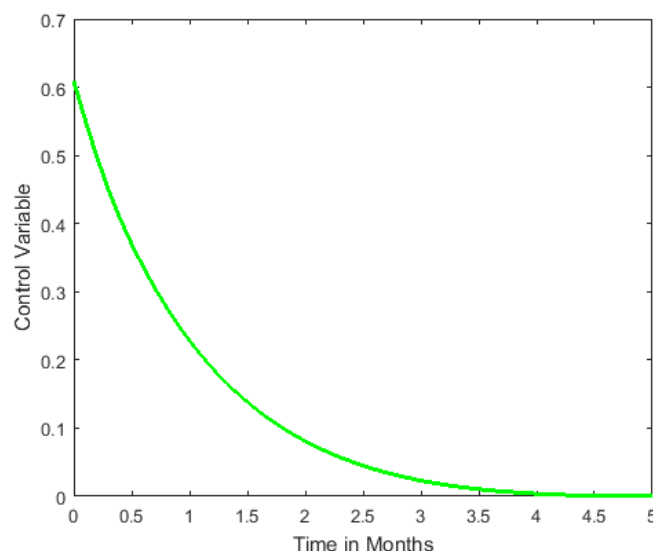
Figure-4: Behavior of treatment

To retain the clean water, 60% treatment is advocated to the polluted water has been shown in figure 4.
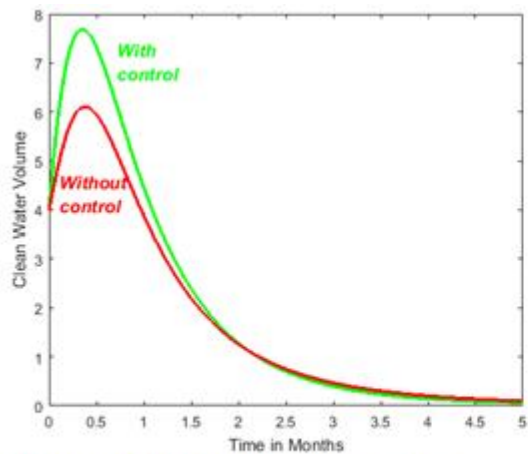
igure-5(a): Clean water volume with
and without control
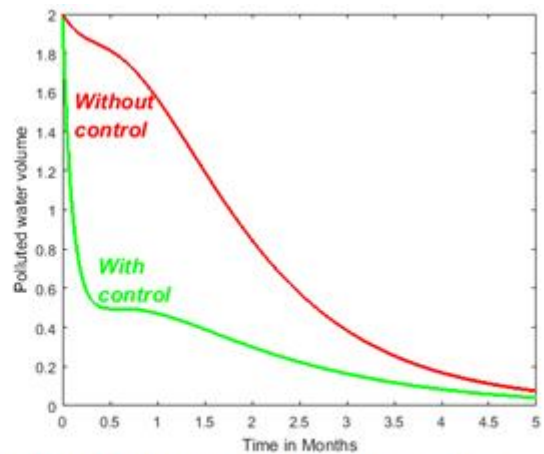
Figure-5(b): Polluted water volume with
and without control

Effect of applied treatment on clean water and polluted water has been depicted in figure 5(a) and 5(b) respectively. Clean water is raised by 25% while volume of polluted water is diminished radically, and then uniformity observed in both the conditions.
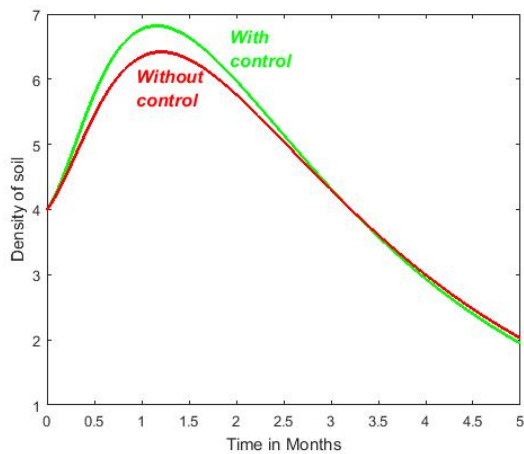
Figure-6: Fertility of soil with and without control

This figure 6 shows the effect of water treatment on soil fertility. It improves by 6% which helps for crop productivity.
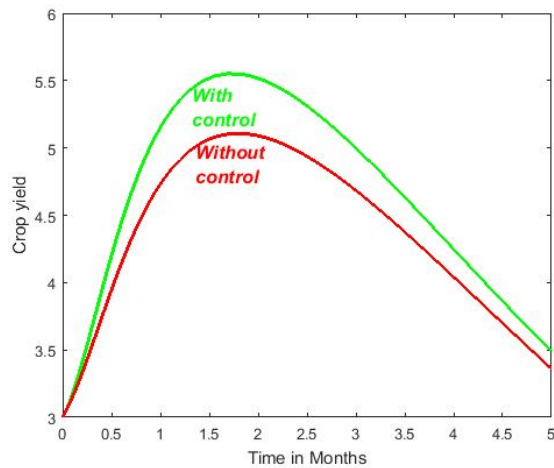
Figure-7: Crop with and without control

Figure 7 suggests 8% increase in crop with 60% treatment on water is attainable compared with no treatment. This reflects that water is one of the essential inputs for the crop production.
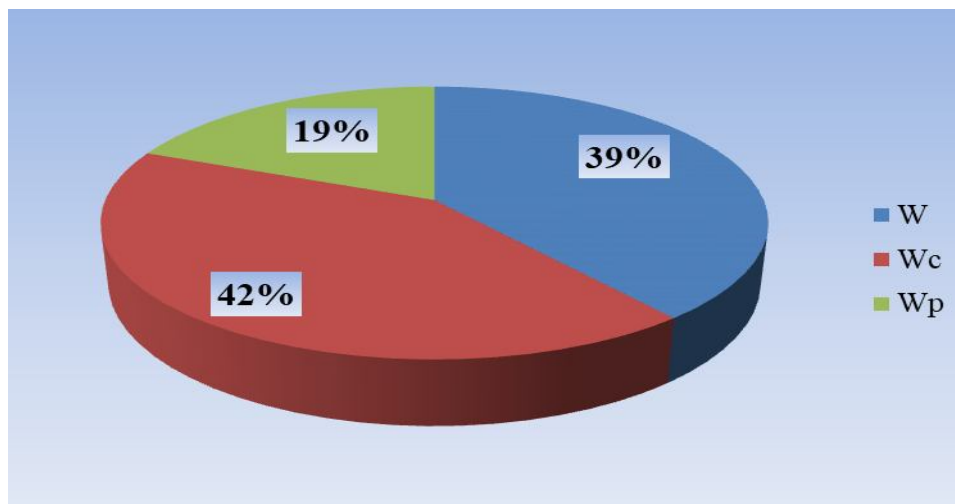
Figure-8: Percentage of water volume

Figure 8 gives relation between textures of water. Out of 39% of water, 42% is clean water whereas 19% water remains polluted. The clean water volume applied directly or indirectly through soil. Hence, it affects to the growth of healthy crop.
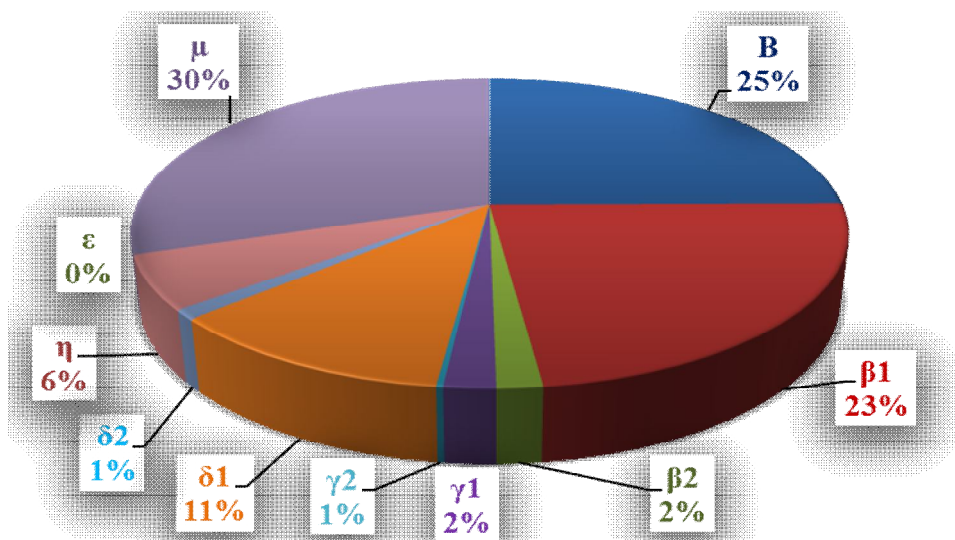
Figure-9: Sensitivity analysis of each parameter

Figure 9 gives sensitivity analysis of each parameter and its impact on the system. The effect of growth rate of water volume (B) is 25% among which density of clean water (β_1) is 23% while polluted water volume (β_2) is only 2%. The chances of clean water volume turns into polluted one is very less, which is not good but there is 50% chances that polluted water will convert into reclaim water. The effect at which clean water directly applied to the crop should be maintained because as it gives negative impact on it. We can see that most affected parameter is μ because if wastage of water is high then clean water volume cannot be attained and this will effect on diminution of crop. So, it is advisable that wastage should be in taken into account.

7. CONCLUSION

In the proposed paper, mathematical model is illustrated using system of non-linear differential equations to establish stability of the crop. Both the equilibrium points of this system are locally and globally asymptotically stable among with some conditions. Based on threshold value, bifurcation analysis is clarified. This indicates that 51% water volume is required for soil fertility because it directly affects crop. Water plays an important key role in soil fertility and crop growth relation. To improve water quality consequently the crop, control as treatment has been applied from polluted water volume to clean water volume. Sensitivity analysis is attained to show the behavior of each parameter on the specified system. Simulation leads to a fact that clean water volume with soil fertility is required for a healthy crop.

Threshold value has been calculated using the parameters given in Table 1. It signifies that 65.15% crop is gained through fertile soil.

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SYNTHESIS AND PHOTOLUMINESCENCE STUDY OF RED EMITTING PHOSPHOR SUITABLE FOR LED APPLICATION

Dr. Devayani Chikte (Awade)

G. N. Khalsa College, Matunga, Mumbai

ABSTRACT

The solid state lighting is emerging as a promising option for domestic lighting due to its several advantages along with energy saving such as environment-friendliness, small volume, and long persistence.

The red emitting phosphor $K_2SiF_6:Mn^{4+}$ is prepared by Wet-Chemical Method and Mn^{4+} activator is incorporated during the synthesis. The powder XRD pattern is in good agreement with ICDD card no.01-075-0694.

The Photoluminescence emission spectrum monitored at 460nm shows sharp red emission spectrum comprises five main peaks, locating at 608, 613, 633, 635, and 648 nm, respectively, which should be assigned to transitions between the vibronic levels of the ^2E_g and $^4A_{2g}$ states of Mn^{4+} ion. The excitation spectrum monitored at 630 nm exhibits two broad bands centred at 350 and 460 nm, which can be assigned to the $^4A_2$ to $^4T_1$ and $^4A_2$ to $^4T_2$ transitions of Mn^{4+} ions. The excitation band shows excellent spread in both NUV and blue region of the spectrum. This makes it potential candidate for LED application.

The phosphor shows CIE 1931 colour coordinates as (0.62, 0.36) indicating red colour emission. The colour co-ordinates are nearer to Adobe red Co-ordinates (0.64,0.33).

Keywords: Luminescence, phosphor, solid state lighting

1. INTRODUCTION

The change in domestic lighting system is obvious with evolution of technology. It is one of the major energy consuming systems and closely associated with the day to day activities. So researchers are trying continuously to improve it for the betterment of human society. The solid state lighting (SSL) is emerging as a promising option for domestic lighting due to its several advantages along with energy saving such as high luminous efficiency, environment-friendliness, small volume, and long persistence [1-3].During past few years white LEDs fabricated using near ultraviolet LEDs (350-410nm) [4,5] coupled with red, green and blue phosphors have attracted much attention due to the advantages of colour stability. Moreover blue LED with Green and Red phosphor is equally popular method to produce white light. However the lack of efficient red phosphor is restricting the further progress. Thus the development of new red phosphors with high quantum efficiencies is highly desirable.

Hexaflurosilicates are a class of materials which are termed as complex fluorides. The general formula is M_2SiF_6 and $NSiF_6$ where M and N are any of the alkali or alkaline earth ions, respectively. Hexa-fluorosilicates have limited thermal stability, hence the conventional methods of phosphor preparation are not suitable to incorporate activators in it. For this reason, there is little work on luminescence in hexa-fluorosilicate hosts. Line emission of Eu^{2+} has been noticed in $BaSiF_6$ and $SrSiF_6$. Quantum cutting using Pr^{3+} activator has been reported in $BaSiF_6$.

Manganese is widely used to activate commercial phosphors, in which its oxidation state is typically 2+. The Mn^{4+} ion exhibits efficient luminescence in some compounds [6,7]. Though luminescence of Mn^{4+} in hexafluorosilicates had been predicted as early as 1973, it has been reported in details for some hexafluorsilicates such as A_2TiF_6 (A = K, Na, Cs, and NH_4) [8], $BaSiF_6$[9], and Ba_2TiF_6[10], only recently.

$K_2SiF_6:Mn^{4+}$ is efficient red-emitting phosphors with blue or near-UV excitation. The intense red emission suggests that it is a suitable candidate for fabrication of white LEDs. Recently researchers have suggested various improvements in the synthesis method of $K_2SiF_6:Mn^{4+}$ phosphor to make the process time saving and economical.

Meyer et al. reported a modified method involving the addition of KHF_2 to $HF/KMnO_4$ solution to increase the F^- and K^+ concentrations in the $HF/KMnO_4$ solution and to control the Mn doping level in the K_2SiF_6 host [11]. The method of synthesizing $K_2SiF_6:Mn^{4+}$ phosphor by etching Si wafers in $HF/KMnO_4$ solution was suggested by Ryota Kasa et al recently[12]. This method produced an efficient red phosphor. The temperature dependence of the photoluminescence (PL) properties of this phosphor was reported by in detail by S. Adachi et-al [13].Chenxing Liao et-al recently suggested modified method for Synthesis of $K_2SiF_6:Mn^{4+}$ Phosphor from

SiO_2 Powders via Redox Reaction in $HF/KMnO_4$ Solution. This method gives larger yield. The application of $K_2SiF_6:Mn^{4+}$ in Warm-White LED is also discussed in detail by them [14].

In the present work $K_2SiF_6:Mn^{4+}$ phosphor is prepared by Wet-Chemical Method and Mn^{4+} activator is incorporated during the synthesis. The common synthesis which is reported in literature is the reaction of alkali or alkaline earth salt with H_2SiF_6. A comparatively simple procedure was adopted in the present work.

2. EXPERIMENTAL

The phosphor is prepared by wet chemical synthesis method. The constituent ingredients used are SiO_2 (AR grade), HF (25Vol%), KMnO4 (GR grade) and hydrogen peroxide (30 vol%). First SiO_2 (analytical reagent grade, 99.9 wt %) powder was dissolved in HF (25 vol%) in ambient environment for 2 h to form H_2SiF_6 solution (labeled as solution A). Then stoichiometric amount of $KMnO_4$ was dissolved in solution A, the color of the solution quickly turned from colorless to deep purple. Then hydrogen peroxide (30 vol%) was added drop wise. The purple solution turned colorless rapidly while yellow precipitate of $K_2SiF_6:Mn^{4+}$ powders were formed within 10 min. The precipitate was filtered out and dried thoroughly in air at 90°C

3. RESULT AND DISCUSSION

XRD analysis
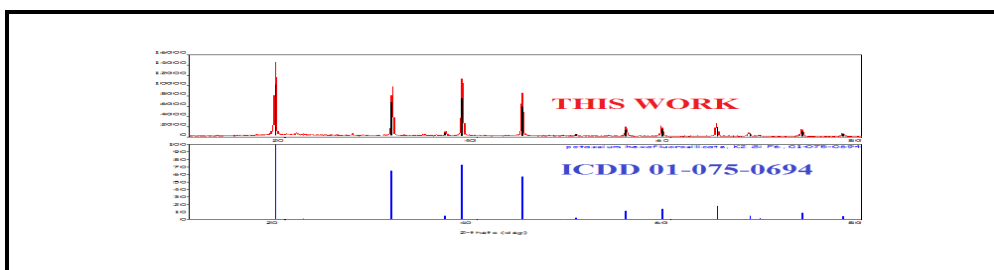
Fig-1: Powder XRD pattern of $K_2SiF_6:Mn^{4+}$

Fig.1 represents the powder XRD pattern of $K_2SiF_6:Mn^{4+}$ phosphor. The XRD pattern is in good agreement with ICDD card no.01-075-0694. Here K_2SiF_6 crystallizes in a cubic crystal structure with a space group Fm3m (No.225). The lattice constant is 8.134Å, with four formula unit per unit cell. The cell volume is 538.16 Å [15].
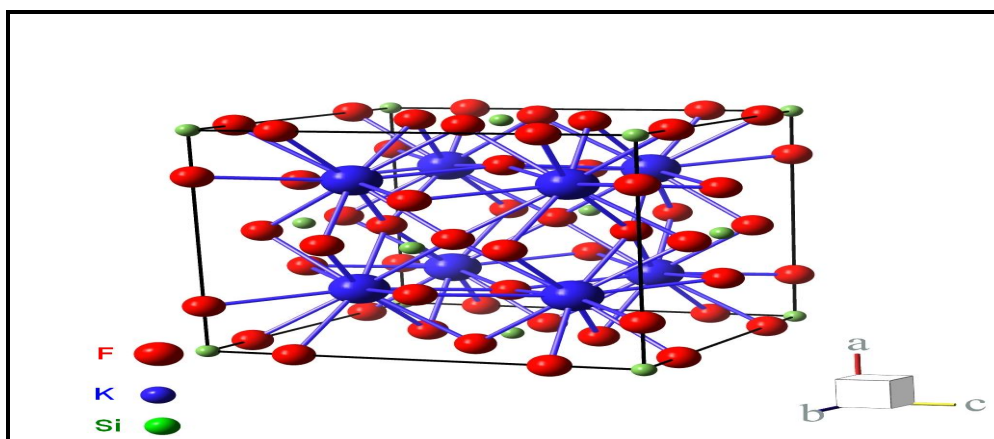
Fig-2: The crystal structure of K_2SiF_6.

Fig.2 indicates the crystal structure of K_2SiF_6. The K^+ ions are 12-fold coordinated by the fluorine ions with the K - F distance of 2.897 Å. The Si^{4+} ions are surrounded by six fluorine ions at the distance of 1.683 Å [16].
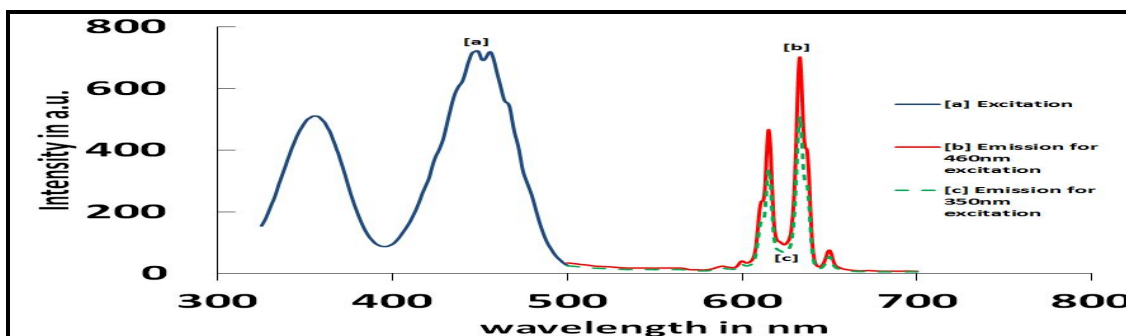

Fig-3: photoluminescence excitation (PLE) and emission (PL) spectrum of $K_2SiF_6:Mn^{4+}$

Fig.3. shows the photoluminescence excitation (PLE) and emission (PL) spectrum of $K_2SiF_6:Mn^{4+}$ measured at room temperature. The PL spectrum obtained with excitation wavelength of 460 nm [b]as well as 350 nm[c] shows the similar profile. The sharp red emission spectrum comprises five main peaks, locating at 608, 613, 633, 635, and 648 nm, respectively, which should be assigned to transitions between the vibronic levels of the ^2E_g and $^4A_{2g}$ states of Mn^{4+} ion. The PLE spectrum obtained by monitoring at λex = 630 nm exhibits two broad bands centred at 350 and 460 nm, which can be assigned to the $^4A_2$ to $^4T_1$ and $^4A_2$ to $^4T_2$ transitions of Mn^{4+} ions, respectively.
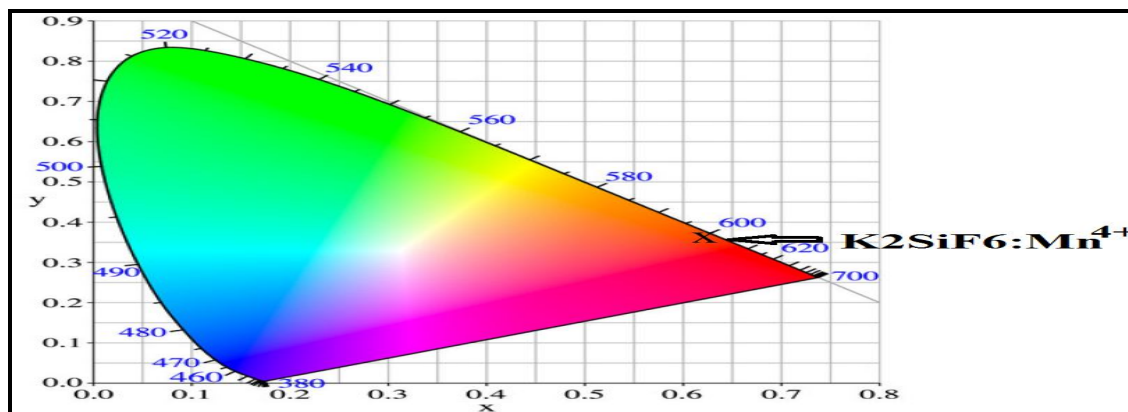
Fig-4: The CIE 1931 colour co-ordinates for $K_2SiF_6:Mn^{4+}$ phosphor.

Fig.4. shows the CIE 1931 colour co-ordinates for $K_2SiF_6:Mn^{4+}$ phosphor. The phosphor shows CIE 1931 colour coordinates as (0.62, 0.36) indicating red colour emission. The colour co-ordinates are nearer to Adobe red Co-ordinates (0.64,0.33) whereas the commercial red phosphor $Y_2O_2S: Eu^{3+}$ shows the colour co-ordinates as (0.62, 0.32).The NTSE standard values for red colour are (0.67,0.33).

CONCLUSION

The red emitting phosphor $K_2SiF_6:Mn^{4+}$ is successfully prepared by Wet-Chemical Method and Mn^{4+} activator is incorporated during the synthesis. The powder XRD pattern is in good agreement with ICDD card no.01-075-0694.

The Photoluminescence emission spectrum monitored at 460nm shows sharp red emission spectrum comprises five main peaks, locating at 608, 613, 633, 635, and 648 nm, respectively, which should be assigned to transitions between the vibronic levels of the ^2E_g and $^4A_{2g}$ states of Mn^{4+} ion. The excitation spectrum monitored at 630 nm exhibits two broad bands centred at 350 and 460 nm, which can be assigned to the $^4A_2$ to $^4T_1$ and $^4A_2$ to $^4T_2$ transitions of Mn^{4+} ions. The excitation band shows excellent spread in both NUV and blue region of the spectrum. This makes it potential candidate for LED application.The phosphor shows CIE 1931 colour coordinates as (0.62, 0.36) indicating red colour emission.

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VERIFIABLE ENCRYPTION TO ENSURE ZERO-KNOWLEDGE BASED SYSTEM FOR OPTIMISTIC FAIR EXCHANGE

S. S. V. VaraLakshmi[1], SK Rukhyakhanam[2], S. Ashwini Chandini[3], Shrey Acharya[4] and Dr. C. Narasimham[5]
Student[1,2,3,4] and Professor[5], Vignan's Institute of information Technology, Duvvada

ABSTRACT
In the current digital era huge amount of data that will be generating, processing, transmitting daily. While some of the information are trivial others are sensitive. As a matter of fact, the security of some information traversing through the internet is critical to the survival of the owner. In this scenario, we would like to present an efficient protocol that allows two parties to exchange some valuable digital data in a fair exchange way. The obvious objective of this project is to ensure Zero-Knowledge based system for effective data transmission without any leakages to the outside vulnerable. In this context, it is proposed to integrate the existing system with verifiable encryption based on Prover and Verifier instead of any trusted third party.

Keywords: Verifiable encryption, verifiable decryption, adaptive chosen ciphertext security, public key encryption.

INTRODUCTION
The two parties who are in a position to prove some property to another party about an encrypted message namely, the party who created the ciphertext, and the party who holds the secret key. A protocol in which the encryptor is the prover is a verifiable encryption protocol, while a protocolin which the decryptor is the prover is a verifiable decryption protocol. For example, suppose a party T has a public key/secret key pair (PK, SK) for a public key encryption scheme. Party A might encrypt, using T's public key PK, a secret message m that satisfies a publicly-defined property θ, and give the resulting ciphertext ψ to another party B. The later party might demand that A prove that ψ is an encryption of a message satisfying property θ. Ideally, the proof should be "zero knowledge," so that no unnecessary information about m is leaked to B as part of the proof. Another party B0 might obtain the ciphertext ψ, and may request that Tprove or

disprove that ψ decrypts under SK to a message m satisfying a publicly-defined propertyθ; a special case of this would be the situation where T simply gives m to B0, and proves to B0 that the decryption was performed correctly. Again, ideally, the proof should be "zero knowledge".

OBJECTIVE/ PURPOSE OF THE WORK
The Aim of this work is to ensure Zero-Knowledge based system for effective data transmission without any leakages to the outside vulnerable. In this context, it is proposed to integrate the existing system with verifiable encryption based on prover and verifier instead of any trusted third party. Further, the main purpose is to develop an efficient methodology that allows two parties to exchange some valuable digital data in a fair exchange manner basing on prover and verifier to ensure zero-knowledge based system.

EXISTING SYSTEM
In existing system, the sender sends an encrypted data to the receiver through communication channel then the receiver receives the encrypted data then decrypts it and gets the original data. Many processes and procedures are available in the literature.
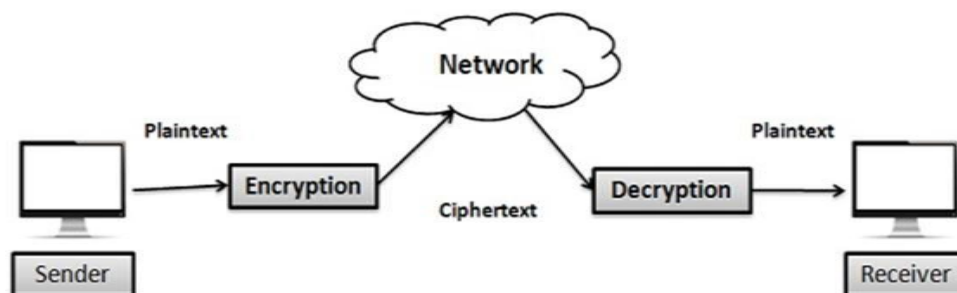

NEED FOR THE WORK
Verifiable encryption is an encryption scheme where one can prove some property of a message *m*, while the message is given in an encrypted form. When an encryption scheme is secure, the encryption E(m) should reveal no information regarding *m*. But this property may not be suitable in cases where checking some property of the encrypted content is required before processing the encrypted data. Verifiable encryption allows a verifier to check certain property of the content that is encrypted.
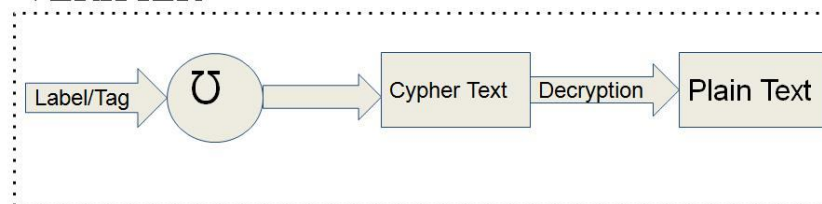
PROPOSED SYSTEM

It is proposed to ensure Zero-Knowledge based system for effective data transmission without any leakages to the vulnerable system. Further, it is proposed to focus on integrating the existing system with verifiable encryption based on Prover and Verifier instead of any Trusted Third Party.
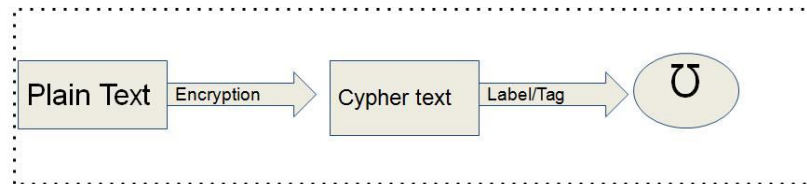
PROVER

DESIGN

Design is the first step in the development phase for any techniques and principles for the purpose of defining a device, a process or system in sufficient detail to permit its physical realization. Once the software requirements have been analyzed and specified the software design involves three technical activities - design, coding, implementation and testing that are required to build and verify the software. The design activities are of main importance in this phase, because in this activity, decisions ultimately affecting the success of the software implementation and its ease of maintenance are made. These decisions have the final bearing upon reliability and maintainability of the system.
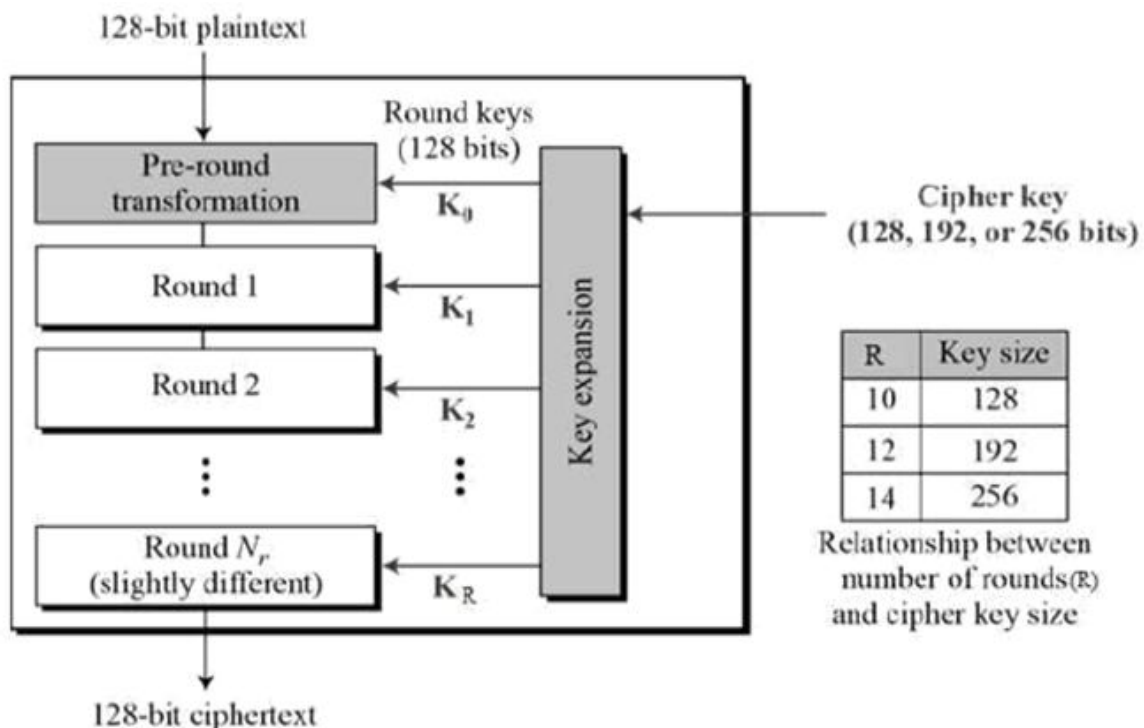
SYMMETRIC CIPHERING USING AES

1. Symmetric key symmetric block cipher128-bit data

2. 128/192/256-bit keys Stronger and faster than Triple-DES

3. Provide full specification and design detail

4. Software implementation is done in C and Java.

SHA-1

SHA-1 or Secure Hash Algorithm 1 is a cryptographic hash function which takes an input and produces a 160-bit (20-byte) hash value. This hash value is known as a message digest. This message digest is usually then rendered as a hexadecimal number which is 40 digits long. SHA-1 is now considered insecure since 2005. Major tech giant's browsers like Microsoft, Google, Apple and Mozilla have stopped accepting SHA-1 SSL certificates by 2017.

OPTIMISTIC FAIR EXCHANGE

The Optimistic Fair Exchange (OFE) is a protocol for solving the problem of exchanging items orservices in a fair manner between two parties, a signer and a verifier, with the help of an arbitrator which is called in only when a dispute happens between the two parties.

IMPLEMENTATION

Implementation is the part of the process where software engineers actually program the code for the project. Here, we are using Iterative model focuses on creating prototypes right from the start. However, these are just stages in development software. The good thing about this is that when the software is implemented it is guaranteed to work based on the preference of the users since they have helped in the creation of the software. The source code has been written in java.

SAMPLE CODE
(AES Encryption)

```
Public static String encrypt(String data) throws Exception {

Key key=generateKey();

Cipher c=Cipher.getInstance(ALGO);

c.init(Cipher.ENCRYPT_MODE,key);

byte[] encVal=c.doFinal(data.getBytes());

return new BASE64Encoder().encode(encVal); }
```

AES Decryption

```
Public static String encrypt(String data) throws Exception { Key key=generateKey();

Cipher c=Cipher.getInstance(ALGO);

c.init(Cipher.DECRYPT_MODE,key);

byte[]          decodeValue=new          BASE64Decoder().decodeBuffer(encryptedData);          byte[]
decValue=c.doFinal(decodeValue); return new String(decValue); }
```

SHA-1 method

```
public static String sha1(String input) {

MessageDigest md = MessageDigest.getInstance("SHA-1"); // getInstance() method is called with algorithm SHA-1.

byte[] messageDigest = md.digest(input.getBytes());// digest() method is called to calculate message digest of the input string returned as array of byte .

BigInteger no = new BigInteger(1, messageDigest);//Convert byte array into signum rep String hashtext = no.toString(16); // Convert message digest into hex value

while (hashtext.length() < 32) { hashtext = "0" + hashtext;} // Add preceding 0s to make it 32 bit return hashtext; // return the HashText; }
```
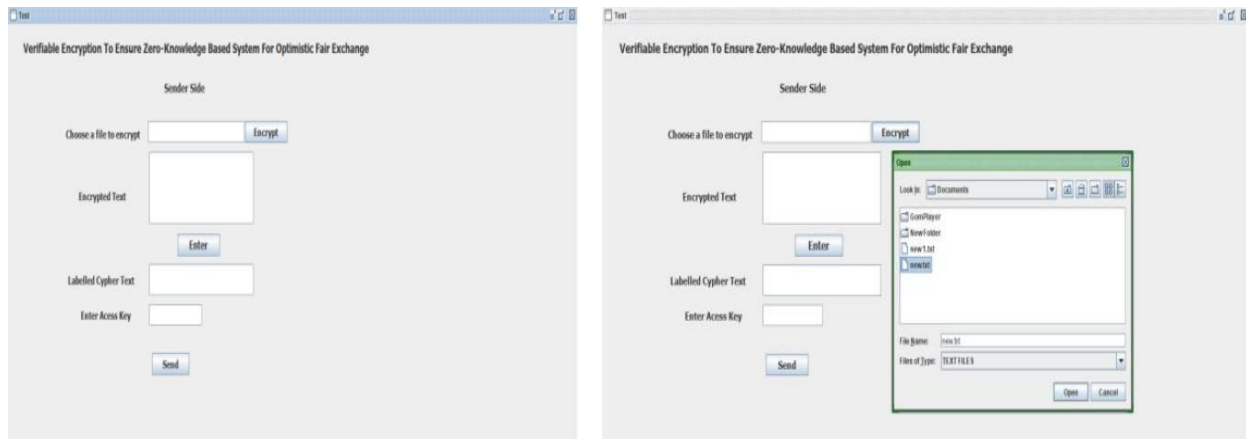
RESULTS AND ANALYSIS

The resultant output is in the form of Graphical User Interface (GUI) using java swings. Here, we need to choose a file from your directory and then it displays your file name in the text field and it encrypts the file using AES encryption and displays in the encrypted text.

After encrypting the text then we needs to enter the button, again the encrypted text will be encrypted using SHA-1 algorithm and it displays in the labelled cipher text.
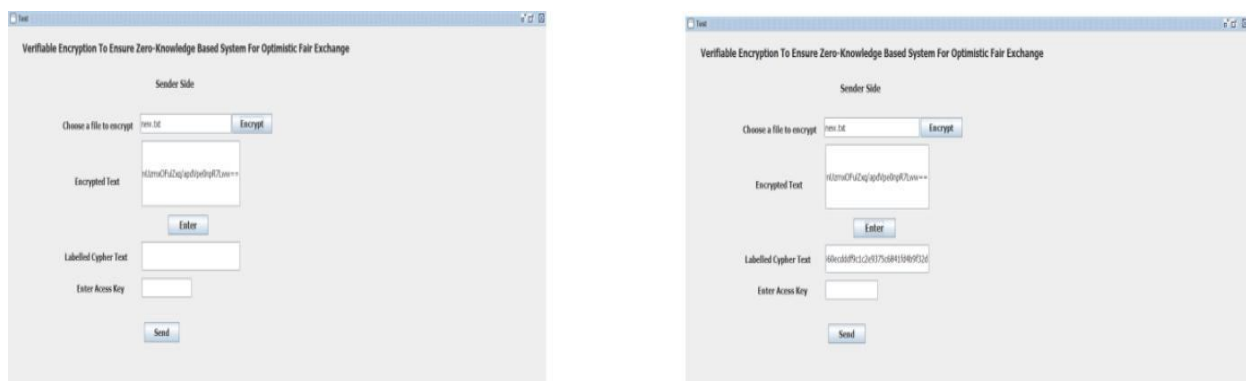

Here, we need enter the user access key to whom we want to send the data or information and click on send button, immediately it displays another window i.e.; Receiver Side
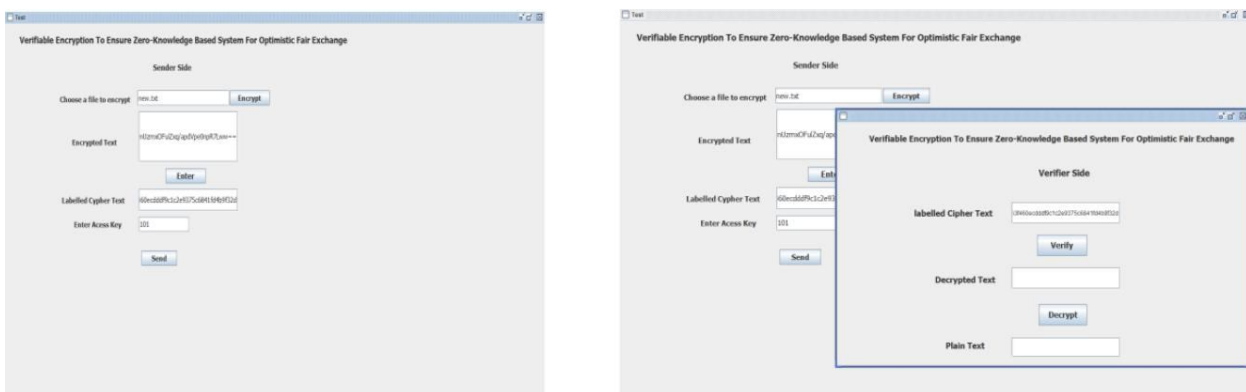
In Receiver side to whom we want to send the data , that particular user should has its own labelled cipher text with him, by clicking on Verify button it verifies whether the particular user is authorised or not. If the user is authorised person then it displays the decrypted text otherwise the pop-up message will displays like "user is not authorised person"
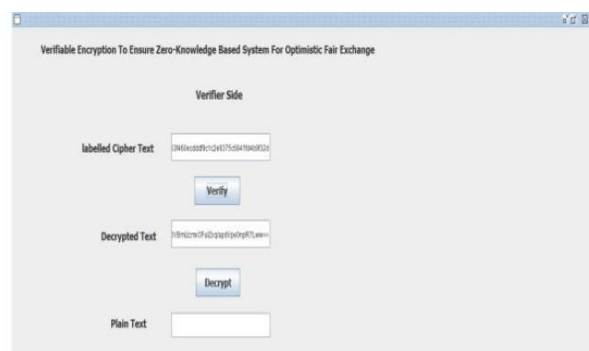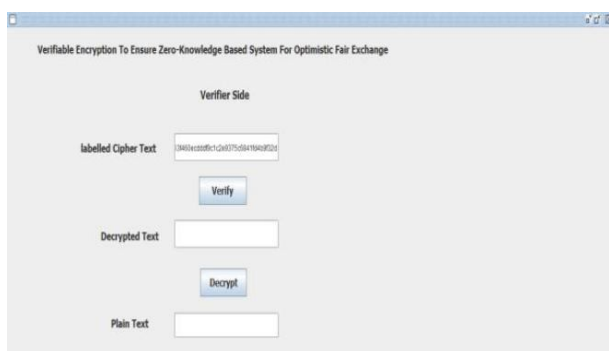
Finally by clicking on Decrypt button the file will be decrypted using AES decryption and it displays the plain text .
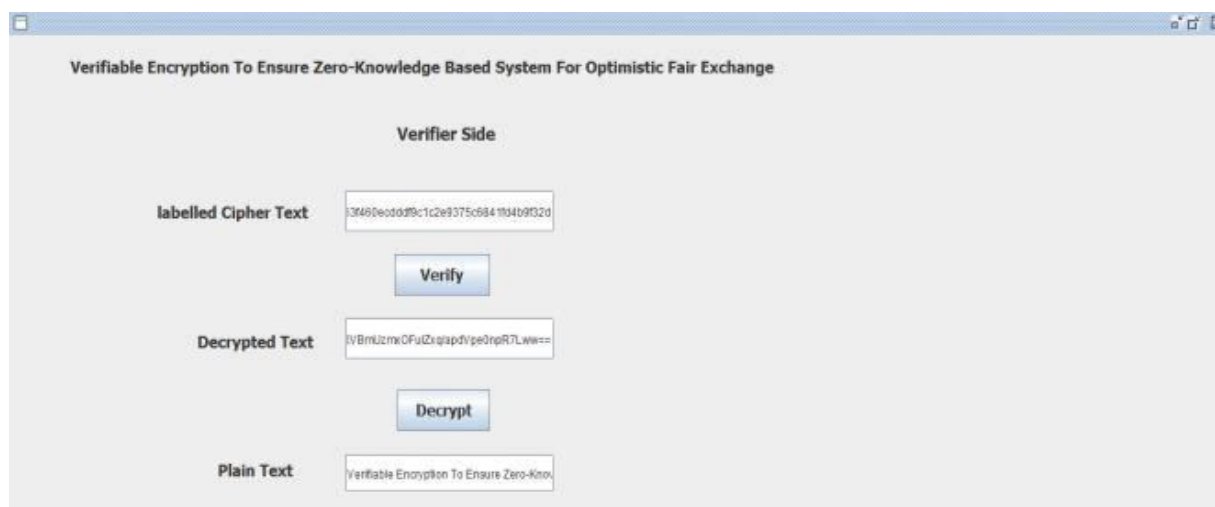
CONCLUSION

The work ensures Zero-Knowledge based system for effective data transmission without any leakages to the outside vulnerable. It was to integrate the existing system with verifiable encryption based on prover and verifier instead of any trusted third party. Furthermore, developed an efficient methodology that allows two parties to exchange some valuable digital data in a fair exchange manner basing on prover and verifier to ensure zero-knowledge based system.

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WATER QUALITY ASSESSMENT OF PONDS AT THANJAVUR DISTRICT - TAMIL NADU

Dr. R. Mohandoss[1], Rajeswari B[2] and C. Sivasubramanian[3]

Assistant Professor[1], Bharathidasan University

Research Scholar[2] and Associate Professor[3], Tamil University, Thanjavur

ABSTRACT

The present work deals with the study of physico-chemical characteristics of comparative study of 25 ponds at Thanjavur district, Tamil Nadu includes analysis of water quality for number of parameter like Temperature, pH, EC,TDS, TA, Chloride, sulphate, DO, TH, CaH, MgH, nitrate, phosphate, iron, Sodium, Turbidity , Potassium and Fe. The selected ponds were stagnant, fresh water ponds and economically (both agriculture and fishery) significant water bodies. Ponds are also good natural rain water harvesting system which used for ground water recharge, water storage tank, provide drinking water for domestic animals etc., The considerable range of variation in many parameters of the ponds were recorded which represent the suitability of the ponds for agriculture activities and so on.

Keywords: ponds, parameters, stagnant, water storage.

INTRODUCTION

Water quality monitoring is an important exercise, which helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures already in existence. *Ramachandra et al., (2011) Manmade waterbodies have traditionally been used for domestic and irrigation purposes. Unplanned urbanisation and ad-hoc approaches have led to these waterbodies receiving untreated sewage. This enriches and eutrophies the water body. Purushottam et al., (2010) Studied the Important variations have occurred in the investigated area as a result of human activity and discharge of waste water. The physico-chemical characteristics of water, aquatic weeds and bank flora of three water reservoirs located in Krishnagar city, West Bengal, India were studied by Das (2009).*The selected water bodies for the present investigation have not been studied so far, although such studies have been extensively carried out on other water bodies of Thanjavur.

MATERIALS AND METHODS

The study was conducted in 25 stagnant water bodies at Thanjavur district, Tamil Nadu. In the present study, samples (during summer and winter) from the ponds were collected in pre-cleaned 1 L polythene bottles with the necessary precaution (Brown *et al.,* 1974). The physicochemical parameters, viz., pH, EC, TDS, Turbidity, TA, CH, MH, TH, DO,Fe, Nitrate,Sulphate,Phosphate, Na, K, Cl and F for the water samples were assessed as per standard procedures (APHA, 1998). List of parameters are given in the table : 1

Table-1: Parameters and methods employed in the physico-chemical examination of water samples

S. No.	Parameter		Methods	Reference
1	Temp^o C	Temperature		
2	p^H	p^H	Electrometric Methods	APHA (1998)
3	EC mmho/cm	Electrical Conductivity	Electrical Conductivity Method	APHA (1998)
4	TDS mg/L	Total Dissolved Solids	Dessicator method	APHA (1998)
5	TA mg/L	Total Alkalinity	Volumetric method	APHA (1998)
6	Cl^- mg/L	Chloride	Argentometric Method	APHA (1998)
7	SO_4^{-2} mg/L	Sulphate	Colorimetric Method	APHA (1998)
8	DO mg/L	Dissolved Oxygen	Winkler's Mayer Method	APHA (1998)
9	TH as $CaCo_3$ mg/L	Total Hardness	Volumetric Method	APHA (1998)
10	CaH as $CaCo_3$ mg/L	Calcium Hardness	Volumetric Method	APHA (1998)
11	MgH as $CaCo_3$ mg/L	Magnesium Hardness	Volumetric Method	APHA (1998)
12	NO_3^- mg/L	Nitrate	Colorimetric Method	APHA (1998)
13	PO_4^{-3} mg/L	Phosphate	Colorimetric Method	APHA (1998)
14	F^- mg/L	Fluoride	Colorimetric Method	APHA (1998)
15	Na mg/L	Sodium	Flame Photometric Method	APHA (1998)
16	Turbidity NTU	Turbidity	Nepleoturbidity meter	APHA (1998)
17	K mg/L	Potassium	Flame Photometric Method	APHA (1998)
18	Fe mg/L	Iron	Colorimetric method	CPCB (2000)

RESULT AND DISCUSSION

The North-East Monsoon which usually bring rain to the study area during October to December results in about 65% of the total rainfall in the year and so is the deciding factor in demarcating various season at the study area. So based on the rainfall seasons can be distinguished at the study area, namely pre monsoon (August – September), Monsoon (October –December) and post monsoon (January – March) since the ponds got dried during March to July data for only eight months from August to March covering only three seasons namely pre monsoon, monsoon and post monsoon. The samples were collected between December to March, for this present study during summer and winter season. Because most of the water bodies are dry for more than six months in the year.

PHYSICO-CHEMICAL PARAMETERS FOR THE WATER SAMPLES

The parameters analysed for the 25 pond water samples include pH, Electrical conductivity, Total Dissolved solids, Calcium Hardness, Magnesium hardness, Total Hardness, Total Alkalinity, Chloride, Fluoride, Fe, DO, Nitrate, Sulphate, Phosphate, Sodium and Potassium.

The above water Quality parameters were assessed both in the Summer and Winter seasons. The Summer season falls between March and June and the winter season between October and January. The summary of physico-chemical parameters for the water samples are shown in Table 2.

Temperature and photoperiod are important factors which control the behaviour, physiology and distribution of organisms. During the present study, the water temperature was ranged from 24.3 to 36.0^{o}C and 22.5 to 26.0^{o}C in the summer and winter seasons respectively.

The summer season was recorded with the minimum and maximum pH values of 6.3 to 8.7 for the samples. The observed pH values in summer and winter indicate that the samples are alkaline in nature. The alkaline nature of the water samples may be due to the presence of aquifer sediments mixed with clay and mud, which are unable to flush off the salts. (Laluraj *et al.,* 2005).

The magnitude of EC reflects the ionic nature of the water sample. Fresh water measured with an EC values of < 500 mmho/cm, whereas the marginal, brackish and saline EC values are measured from 500 mmho/cm to 1500 mmho/cm, > 1500 mmho/cm respectively (Adil Elkrail, 2003). For the water samples, EC was measured from 1.52 mmho/cm to 830.1 mmho/cm in Summer and 54.6 mmho/cm to 992.2 mmho/cm in winter. From the observed values in summer, the samples was found to be marginal category.

The effect of monsoon on the quality of the water samples is due to the dilution and the recharging of the water. The greater EC values indicate the participation of rain water ingress (Narayana, 1989 & Ramesh, 1995). Which ultimately contaminates these fresh aquifers. It was reported that the greater conductivity of the water samples was due to the alluvial sandy clay in the depth section, by Subbarao *et al.* 2006.

The TDS value for water samples was ranged from 50 mg/L to 500 mg/L in summer and 63 mg/L to 864 mg/L in winter. According to TDS classification, (Fetter, 1990) 95% of the water samples with fresh type (TDS<1000 mg/L) in summer was increased in winter. The high TDS content of the water samples may cause unfavourable physiological reaction in transient consumers like constipation. (Kumarasamy, 1991).

The Calcium hardness (CH) content of the water samples was ranged from 40.7 mg/L to 246.0 mg/L in Summer and from 28.5 mg/L to 250 mg/L in Winter. According to the WHO recommended limit (75-200 mg/L), both summer and winter samples was observed to be within the permissible limit. The calcium hardness in summer was greater than winter in all the water samples, which may be attributed to the exchange of Na^+ for Ca^{2+} ions. It was reported (Kumarasamy, 1991) that the exchange during the dry season is more dominant than in the winter season. This confirms that the dominant summer season leaves more Ca^{2+} ions into the water than in the winter season. It was also reported by Chi-man Lenng *et al.,* 2005 & Back. W,1960.

The range of magnesium Hardness (MH) in Summer and winter was recorded as 10.0 to 641 mg/L and 20 mg/L to 161 mg/L respectively. In Summer, as per the guidelines of WHO (30-150 mg/L), MH in 4 samples were found to be below the permissible limit and in 18 samples, it was within the permissible limit. In winter, 22 samples were recorded to be within the permissible limit and 3 samples were found to be above the permissible limit. The decrease in MH content was observed from summer to winter.

In summer, the amount of Total hardness (TH) was registered between 64 mg/L and 739 mg/L. As per the guidelines of WHO (100-500 mg/L), the recorded values for 24 samples were found in the permissible limit and one sample was exceeded the permissible limit. In winter the TH was recorded to be between 56 mg/L and 390 mg/L. 6 samples was characterized with soft nature (<100 mg/L) and 18 samples were found to be within the

permissible limit in summer. The remaining one sample was observed to be above the permissible level by indicating the very hard nature of the water samples.

According to TH classification, (Sawyer, 1967) the water samples with the TH content between 150 mg/L and 300 mg/l are hard and the values exceeding 300 mg/L are very hard. In summer, about 4 of the water samples exhibited a very hard nature belonging to the non-carbonate hardness (TH>TA: Chow, 1964). The excessive calcium content of the water samples may be attributed to the abundant concentration of the calcium rich minerals such as gypsum and calcite in the study area. But in winter, one sample fell under the hard nature and the reason may be attributed to the influence of the meteoric precipitation.

The total alkalinity (TA) of the water samples in summer and in winter ranged from 15 mg/L to 170 mg/L and 62 mg/L to 162 mg/L respectively. According to WHO, the TA limit is 200 mg/L, The assessed values of both the period had a TA value smaller than the permissible limit. When compared to the summer period the winter value was greater in all the samples.

The Chloride (Cl^-) content of the water samples ranged from 10.1 mg/L to 43.0 mg/L and 31.0 mg/L to 264 mg/L in the summer and winter respectively. In the summer, which recorded less than 200 mg/L and the samples measured within the permissible limit (200 – 600 mg/L: WHO). In winter, there were 5 samples with above 200 mg/L of WHO. The enrichment of the Cl^- content in these samples may be due to the salt water ingress into these aquifers. (Maurizo Polemio, 2002).

The Fluoride (F^-) content of the water samples was registered as ranging from 0.12 mg/L to 2.1 mg/L in the summer and 0.41 mg/L to 1.5 mg/L in the winter. A total of 9 water samples in summer and one sample in winter were found to be above limit of 1.5 mg/L (WHO: 2004). The low fluoride content in the sample, may be attributed to the strong adsorption of F^- by the soil consisting mostly of clay layers in the subsurface lithology (Shaji, 2007 & Mc Nelly, 1979) where the Fluoride content in both the seasons was recorded as minimum. It may also be deemed that the iron oxide in the soil, may specifically remove fluoride by exchanging the coordinated OH^- and thus the F^- content in water is minimum. A similar report was made by the Shao *et al.,*1984, when he studied the ion adsorption characteristics of some iron oxides.

Turbidity is a principle physical characteristic of water. It is caused by suspended matter or impurities includes clay, silt, finely divided inorganic and organic compounds that interfere with the clarity of the water. Clarity is important in water for human consumption. In the study area the turbidity occurs in the surface water. It ranged from 1.2 to 6.2 NTU in summer and 0.4 to 12.2 NTU in winter. However the prescribed limit of Turbidity for water is 10 NTU (ISI).

Sodium is extremely soluble and increases its solubility as the temperature of water rises. In concentrations over 30 to 40 grains per gallon, sodium salts may give water an unpleasant taste. A maximum of 60% sodium in groundwater is allowed for agricultural purposes (Ramakrishna, 1998). Sodium in the water samples collected in the study area lies in the range from 8.7 mg/L to 54.8 mg/L and 55 mg/L to 273 mg/L in both seasons.

Potassium of water samples collected from the study area lies in the range of 3.4 mg/L to 32 mg/L in summer and 8.7 mg/L to 85.2 mg/L in winter. The permissible limit of potassium is 10mg/L. In the study area most of the samples were exceeded the permissible limit.

The major physiological effects resulting from the ingestion of large quantities of sulphate are catharsis, dehydration, and gastrointestinal irritation. The prescribed limit of sulphate by WHO standard is 200mg/L. In this study area the sulphate level was very low when compared to the permissible limit. The data recorded maximum of 18.2 mg/L in summer and 7.6 mg/L in winter. The lower value was recorded 1.0 mg/L to BDL in both season. This low level of sulphate may understand that this area water was not found to be hard.

Table-2: Summary of season-wise chemical composition of water samples

Parameters	Summer			Winter		
	Min	Max	Mean	Min	Max	Mean
T^oC	24.3	36		22.5	26	
p^H	6.34	8.7	7.594	6.2	8.6	7.2788
EC mmho/cm	1.52	830.1	183.344	54.6	992.2	265.008
TH (mg/L)	64	739	220.517	56	390	134.872
CH (mg/L)	40	246	101.477	28	250	92.952
MH (mg/L)	10	641	119.04	20	161	63.16
TA(mg/L)	15	170	91.3336	62	162	124.408

DO(mg/L)	1.4	12.2	7.5644	1.2	6.4	5.364
NO_3^- (mg/L)	0	28.1	5.5848	0.02	27	10.4332
SO_4^{-2} (mg/L)	1	18.2	6.8176	0	7.6	0.7688
PO_4^{-3} (mg/L)	0	44.8	7.2956	0.02	44.8	5.418
F^-(mg/L)	0.12	2.1	1.1796	0.41	1.5	1.0364
TDS (mg/L)	50	500	582.32	63	864	366.32
K (mg/L)	8.7	85.2	24.124	3.4	32	19.544
Na (mg/L)	8.7	54.8	24.3808	55	273	131.84
Turbidity (NTU)	1.2	6.2	3.364	0.49	12.2	4.0152
Cl^-	10.12	43	21.5928	31.06	264	110.856
Fe (mg/L)	0.01	2.2	0.5776	0	5.2	0.8172

The dissolved oxygen varied from 1.4 mg/L to 12.2 mg/L in summer and 1.2 mg/L to 6.4 mg/L in winter respectively. Low content of DO, a sign of organic pollution, is also due to inorganic reductants like hydrogen sulphide, ammonia, nitrates, ferrous ion and other such oxidisable substances (Ara *et al.*, 2003).

In this study, phosphate was found from BDL to 44.8 mg/L in summer and 0.02 mg/L to 44.8 mg/L in winter. These values were higher than those of David (1963), Pahawa and Mehrotra (1966). They added that the area from which the samples were taken was polluted. Their reported value was 1.00 mg/L. The nitrate level in this study was in the range of BDL – 28.1 mg/L in summer respectively. In winter the values ranged from 0.02 mg/l to 27.0 mg/L respectively. The high values suggested that there is the presence of pollutants like bacteria and pesticides. This can be remedied by water change and increase in plant density. The minimum Fe value of 0.01 mg/L and BDL in summer and the maximum level of 2.2 mg/L and 5.2 mg/L in winter was observed.

CONCLUSION

The quality rating of the water quality parameters are almost poor for potable purposes of cattle and human being both. Most of the parameters were within the surface water quality limit. But the physical view of the ponds show the open defecation, mixing of drainage water, streams run off etc., The reason for poor water quality status is due to accumulation of various types of pollutants in water. In this recent era, ponds have immense importance that a periodical research and timely monitoring of water bodies are very much important to keep them in a healthy conditions and to take necessary measures to undertake the pollution problems, encroachment (real estate), eutrophic etc.,

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