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Drought and Saline Conditions

A Case Study of Latur District

Highlights

Productivity in Grain Farming

Taeniosis/Cysticercosis Disease

Discovering Thoughts, Inventing Future

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AGRICULTURE & VETERINARY

Dr. Bingyun Li

Ph.D. Fellow, IAES, Guest Researcher, NIOSH, CDC, Morgantown, WV Institute of Nano and Biotechnologies West Virginia University, United States

Dr. Matheos Santamouris

Prof. Department of Physics, Ph.D., on Energy Physics, Physics Department, University of Patras, Greece

Dr. Fedor F. Mende

Ph.D. in Applied Physics, B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Dr. Yaping Ren

School of Statistics and Mathematics, Yunnan University of Finance and Economics, Kunming 650221, China

Dr. T. David A. Forbes

Associate Professor and Range Nutritionist Ph.D. Edinburgh University - Animal Nutrition, M.S. Aberdeen University - Animal Nutrition B.A. University of Dublin- Zoology

Dr. Moaed Almeselmani

Ph.D in Plant Physiology, Molecular Biology, Biotechnology and Biochemistry, M. Sc. in Plant Physiology, Damascus University, Syria

Dr. Eman M. Gouda

Biochemistry Department, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt

Dr. Arshak Poghossian

Ph.D. Solid-State Physics, Leningrad Electrotechnical Institute, Russia Institute of Nano and Biotechnologies Aachen University of Applied Sciences, Germany

Dr. Baziotis Ioannis

Ph.D. in Petrology-Geochemistry-Mineralogy Lipson, Athens, Greece

Dr. Vyacheslav Abramov

Ph.D in Mathematics, BA, M.Sc, Monash University, Australia

Dr. Moustafa Mohamed Saleh Abbassy

Ph.D., B.Sc, M.Sc in Pesticides Chemistry, Department of Environmental Studies, Institute of Graduate Studies & Research (IGSR), Alexandria University, Egypt

Dr. Yilun Shang

Ph.d in Applied Mathematics, Shanghai Jiao Tong University, China

Dr. Bing-Fang Hwang

Department of Occupational, Safety and Health, College of Public Health, China Medical University, Taiwan Ph.D., in Environmental and Occupational Epidemiology, Department of Epidemiology, Johns Hopkins University, USA Taiwan

Dr. Giuseppe A Provenzano

Irrigation and Water Management, Soil Science, Water Science Hydraulic Engineering , Dept. of Agricultural and Forest Sciences Universita di Palermo, Italy

Dr. Claudio Cuevas

Department of Mathematics, Universidade Federal de Pernambuco, Recife PE, Brazil

Dr. Qiang Wu

Ph.D. University of Technology, Sydney, Department of Mathematics, Physics and Electrical Engineering, Northumbria University

Dr. Lev V. Eppelbaum

Ph.D. Institute of Geophysics, Georgian Academy of Sciences, Tbilisi Assistant Professor Dept Geophys & Planetary Science, Tel Aviv University Israel

Dr. Linda Gao

Ph.D. in Analytical Chemistry, Texas Tech University, Lubbock, Associate Professor of Chemistry, University of Mary Hardin-Baylor, United States

Prof. Jordi Sort

ICREA Researcher Professor, Faculty, School or Institute of Sciences, Ph.D., in Materials Science Autonomous, University of Barcelona Spain

Angelo Basile

Professor, Institute of Membrane Technology (ITM) Italian National Research Council (CNR) Italy

Dr. Eugene A. Permyakov

Institute for Biological Instrumentation Russian Academy of Sciences, Director Pushchino State Institute of Natural Science, Department of Biomedical Engineering, Ph.D., in Biophysics Moscow Institute of Physics and Technology, Russia

Dr. Bingsuo Zou

Ph.D. in Photochemistry and Photophysics of Condensed Matter, Department of Chemistry, Jilin University, Director of Micro- and Nano- technology Center, China

Prof. Dr. Zhang Lifei

Dean, School of Earth and Space Sciences, Ph.D., Peking University, Beijing, China

Dr. Bondage Devanand Dhondiram

Ph.D. No. 8, Alley 2, Lane 9, Hongdao station, Xizhi district, New Taipei city 221, Taiwan (ROC)

Dr. Hai-Linh Tran

Ph.D. in Biological Engineering, Department of Biological Engineering, College of Engineering, Inha University, Incheon, Korea

Dr. Latifa Oubedda

National School of Applied Sciences, University Ibn Zohr, Agadir, Morocco, Lotissement Elkhier N66, Bettana Sal Marocco

Dr. Yap Yee Jiun

B.Sc.(Manchester), Ph.D.(Brunel), M.Inst.P.(UK) Institute of Mathematical Sciences, University of Malaya, Kuala Lumpur, Malaysia

Dr. Lucian Baia

Ph.D. Julius-Maximilians, Associate professor, Department of Condensed Matter Physics and Advanced Technologies, Department of Condensed Matter Physics and Advanced Technologies, University Wrzburg, Germany

Dr. Shengbing Deng

Departamento de Ingeniera Matemtica, Universidad de Chile. Facultad de Ciencias Fsicas y Matemticas. Blanco Encalada 2120, Piso 4., Chile

Dr. Maria Gullo

Ph.D., Food Science and Technology Department of Agricultural and Food Sciences, University of Modena and Reggio Emilia, Italy

Dr. Fabiana Barbi

B.Sc., M.Sc., Ph.D., Environment, and Society, State University of Campinas, Brazil Center for Environmental Studies and Research, State University of Campinas, Brazil

Prof. Ulrich A. Glasmacher

Institute of Earth Sciences, Director of the Steinbeis Transfer Center, TERRA-Explore, University Heidelberg, Germany

Dr. Yiping Li

Ph.D. in Molecular Genetics, Shanghai Institute of Biochemistry, The Academy of Sciences of China Senior Vice Director, UAB Center for Metabolic Bone Disease

Prof. Philippe Dubois

Ph.D. in Sciences, Scientific director of NCC-L, Luxembourg, Full professor, University of Mons UMONS Belgium

Nora Fung-yee TAM

DPhil University of York, UK, Department of Biology and Chemistry, MPhil (Chinese University of Hong Kong)

Dr. Rafael Gutirrez Aguilar

Ph.D., M.Sc., B.Sc., Psychology (Physiological), National Autonomous, University of Mexico

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Ph.D in Biotechnology, M.Sc in Biotechnology, B.Sc in Botany, Zoology and Chemistry, Gorakhpur University, India

Ashish Kumar Singh

Applied Science, Bharati Vidyapeeth's College of Engineering, New Delhi, India

Dr. Ferit Gurbuz

Ph.D., M.SC, B.S. in Mathematics, Faculty of Education, Department of Mathematics Education, Hakkari 30000, Turkey

Dr. Maria Kuman

Ph.D, Holistic Research Institute, Department of Physics and Space, United States

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Comprehensive Review of Key Taenia Species and Taeniosis/Cysticercosis Disease in Animals and Humans

By Arss Secka

Fiji National University

Abstract- This manuscript provides a comprehensive review of the Taenia genus, encompassing 44 reported species, and their impact on domestic and wild animals as well as humans. The review focuses on 10 important Taenia species and covers various aspects including their description, life cycle, epidemiology, clinical signs of taeniosis and cysticercosis, diagnosis, treatment, control, and prevention.

While humans primarily serve as the definitive hosts for Taenia asiatica, T. saginata, and T. solium, they can also become intermediate/accidental hosts for larval forms (metacestodes) of Taenia crassiceps, T. multiceps, T. serialis, T. solium, and T. Taeniaeformis.

Keywords: tapeworm, taenia, taeniosis, cysticercosis, neurocy sticercosis, epidemiology, diagnosis, treatment, control, prevention.

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COMPREHENSIVEREVIEWOFKEYTAENIASPECIESANDTAENIOSISCYSTICERCOSISDISEASEINANIMALSANDHUMANS

Strictly as per the compliance and regulations of:

Comprehensive Review of Key Taenia Species and Taeniosis/Cysticercosis Disease in Animals and Humans

Arss Secka

Abstract- This manuscript provides a comprehensive review of the Taenia genus, encompassing 44 reported species, and their impact on domestic and wild animals as well as humans. The review focuses on 10 important Taenia species and covers various aspects including their description, life cycle, epidemiology, clinical signs of taeniosis and cysticercosis, diagnosis, treatment, control, and prevention.

While humans primarily serve as the definitive hosts for *Taenia asiatica, T. saginata,* and *T. solium*, they can also become intermediate/accidental hosts for larval forms (metacestodes) of *Taenia crassiceps, T. multiceps, T. serialis, T. solium,* and *T. Taeniaeformis*. These larval forms can cause a range of pathologies in the brain, liver, muscle, eye, and subcutaneous tissue. Human cysticercosis, particularly from *T. solium*, results in significant hospital treatment costs, loss of productivity, and even death.

Cysticercosis caused by eight out of the ten reviewed Taenia species in domestic livestock leads to economic and productivity losses. *Taenia solium, T. asiatica,* and *T. hydatigena* are associated with porcine cysticercosis; *T. saginata* causes bovine cysticercosis; *T. hydatigena, T. multiceps* and *T. ovis* cause cysticercosis in sheep and goats; and *T. pisiformis* and *T. serialis* cause cysticercosis in rabbits.

Control and prevention interventions primarily focus on *Taenia solium* infection. Strategies employed include meat inspection, mass screening and treatment of human carriers, treatment and vaccination of pigs, improved sanitation and slaughtering facilities, and health education. However, sustainability remains a significant challenge in effectively controlling this cosmopolitan zoonotic parasite.

Keywords: tapeworm, taenia, taeniosis, cysticercosis, neurocy sticercosis, epidemiology, diagnosis, treatment, control, prevention.

I. Introduction

Taeniosis and cysticercosis are parasitic infections caused by various adult and larval forms of tapeworms in the genus Taenia in animals and humans leading to production losses, negative socio-economic consequences, nervous and muscular disorders, and even death in very severe instances.

The life cycles of the tapeworms are indirect, involving both intermediate and definitive hosts. Many domestic animals like cattle, goat, sheep, and pigs function as intermediate host where ingested eggs hatch and develop into infective larvae that localize in muscular structures and visceral organs. Humans and dogs are the definitive hosts of many tapeworms where ingested larvae develop into mature adults that shed their eggs into the environment. Humans could also be infected by the larval forms that could lead to neurocysticercosis which is associated with epileptic seizures.

In general, taeniosis and cysticercosis in animals and humans often manifest mild clinical signs except human neurocysticercosis and few other cases with massive infection by adult worms and larvae. Production losses are associated with carcass condemnation, reduced productivity, and high medical costs for managing neurocysticercosis in humans. Diagnoses of these diseases involves history taking, physical examination, meat inspection, coprology, serology, molecular and imaging techniques. Treatment is achieved by use of anthelmintics, anti-inflammatory, anticonvulsive drugs, and other supportive or nonspecific treatments. Control and prevention interventions include massive screening and treatment of carriers, improved human sanitary practices, better animal husbandry practices, meat inspection, vaccination and treatment of pigs, health education, and safe eating habits.

This review discusses the descriptive morphology, lifecycle, and epidemiology of 10 Taenia species, the clinical signs, diagnosis, treatment, prevention, and control of taeniosis and cysticercosis in animals and humans.

II. Description of 10 key Tapeworm Species

Tape worms are classified under the Genus *Taenia*, Family *Taenidae*, Order *Cyclophyllidea*, Subclass *Eucestoda,* Class *Cestoda*, Phylum *Platyhelminthes*, and Kingdom *Animalia* (Taylor et al., 2015). There are 32 species and three subspecies of tapeworms based on Verster's (1969) taxonomy of the genus Taenia Linnaeus (Verster, 1969) which has been updated by (Loos-Frank, 2000) to 39 species and five subspecies, totaling to 44 species/subspecies. He also supplied more information on the hosts affected, geography range, synonyms, larval characteristics, and number of hooks. To capture the species of greater

Author: Fiji National University, College of Agriculture, Fisheries & Forestry, Koronovia, Fiji Islands.
e-mails: arss.secka@fnu.ac.fj, seckaarss@gmail.com

veterinary and zoonotic importance, this review focus on the following 10 species of the genus Taenia:

a) Taenia Asiatica (SYN. Taenia Saginata Asiatica)

Taenia asiatica is predominantly found in Asia, and its morphology and lifecycle are similar with *Taenia saginata* except that in the intermediate pig host it is localized in the liver. The adult worm measures about 3.5 m long, has a scolex with four suckers and the rostellum is surrounded by two rows of rudimentary hooklets. It has posterior protruberances in the gravid proglottid, which are absent in all other tapeworms. The metacestode differs morphologically from that of *T. saginata* in having wart-like formations on the external surface of the bladder wall (Taylor et al., 2015).

Life Cycle

The definitive host for *T. asiatica* is humans while pigs act as natural intermediate hosts, but cattle, goats and certain monkey species were found to be infected with the metacestode forms (Eom et al., 1992; Fan, 1988). Mature cysts are detected in the intermediate host after four weeks following ingestion of the eggs which hatch in the intestines and the oncospheres traverse through the hepatic portal circulation to the liver. The metacestodes are mainly found in the liver of pigs, but could also be found in lungs, omentum, serosa, mesentery, and peritoneum (Chung et al., 1996; Eom et al., 1992; Zhang et al., 1999). It has been reported that humans start excreting motile tapeworm segments along with the stool, about 0 to 35 proglottids daily, two to four months following ingestion of viable cysts in infected pigs' liver (Chang et al., 2006; Chao et al., 1988; Eom et al., 1992). Humans acting as intermediate host, as with *Taenia solium*, are not reported (Ale et al., 2014).

Epidemiology

The risk factors for transmission of *T. asiatica* are consumption of raw pork viscera for human infection and open defecation for infection of the intermediate host. Since the consumption of raw pig viscera is more associated to social, cultural, and religious practices of certain groups of people, the prevalence therefore is more localized in certain foci such as islands within many Asian countries (Ale et al., 2014).

b) Taenia Crassiceps

Adult worms grown in the hamster gut have varying lengths, but gravid proglottids with viable eggs are found in the 82nd proglottid at 27–34 days post inoculation. Its scolex has four suckers and the rostellum bears thorn-shaped hooks (Willms & Zurabian, 2010). The microscopic structure of immature and maturing proglottids are similar but appear smaller in size than those obtained from natural infections. Mature tapeworms have a continuous array of apoptotic cells in the sub-tegumentary tissues suggesting constant replacement by new cells. The testes and vas deferens in mature proglottids have filiform spermatids, with a single axoneme and an elongated helicoidal nucleus inserted between the axoneme and the spiral cortical microtubules. The spermatids conform to type III spermiogenesis. The larval metacestode stage reproduces asexually by exogenous budding (Willms & Zurabian, 2010), which may enhance intraspecific variation and formation of new strains (Smyth & Smyth, 1964).

Life Cycle

The indirect lifecycle of *T. crassiceps* involves a definitive host (foxes and dogs) where the adult worm lodges in the small intestine releasing infective eggs that are expelled outside with the host feces are ingested by the intermediate hosts (wild rodents). Hatched oncospheres cross the intestinal epithelium, lodge in body cavities and subcutis tissues; multiply asexually by exogenous budding (Loos-Frank, 2000) and differentiate to the cysticercus (metacestode) cysts that are ingested by the definitive host where it grows into adult within the duodenum (Willms, 2008).

Epidemiology

Taenia crassiceps is a cosmopolitan cestode parasite endemic to the northern hemisphere, including Europe, North America, and Asia. Main transmission route to the intermediate host (dogs, cats, and humans) is through ingestion of infective eggs along contaminated feed or water. Environmental contamination with infective eggs leading to cysticercosis is also a risk factor for infection (Wünschmann et al., 2003).

A 38-year-old man with severe acquired immunodeficiency syndrome (AIDS) with lesions of a fluctuant, painful, subcutaneous, and intermuscular tumor embedded in deep tissues of the forearm was found to be caused by cysticerci of *Taenia crassiseps* (François et al., 1998). Many other *T. crassiceps* cysticercosis cases in immunosuppressed humans involving the cerebellum, subcutis, muscle, upper limb and eye (subretinal, anterior chamber) have been reported in France, Austria, Germany, Canada, Switzerland and United States of America (Ntoukas et al., 2013).

c) Taenia Hydatigena (SYN. Taenia Marginata, Cysticercus Tenuicollis)

Adult worm measures up to 5 m, and its large scolex has 2 rows of 26 and 46 rostellar hooks, respectively. Mature gravid proglottids are 12 mm long and 6 mm wide, and their uterus has 5–10 lateral branches (Taylor et al., 2015). Eggs are oval and 36-39 by 31-35 μm (Köhler, 1997). The cysticercus is semi-transparent, 5–7 cm in size, contains a watery fluid and invaginated scolex with a long neck (Taylor et al., 2015).

Life Cycle

The life cycle is indirect involving dogs and wild canids as definitive hosts whilst the intermediate hosts are sheep, goats, cattle, and pigs. The intermediate hosts are infected through the ingestion of infective eggs. The oncospheres crosses the intestines into the portal veins to the liver where they migrate through the parenchyma within 4 weeks after infection. Within another 4 weeks, the oncospheres develop into mature metacestodes (Cysticercus tenuicollis) and remain attached to the greater omentum, liver, mesentery, and other abdominal organs. The metacestode measures 6 cm long, has a long thin neck with a single scolex (Köhler, 1997; Taylor et al., 2015). The life cycle is completed in the definitive host's small intestine within 51 days after ingestion of the metacestodes and stays infective for more than one year.

Epidemiology

The epidemiology and transmission of *Taenia hydatigena* in sheep and dogs are important due to the necrotic hemorrhages in the liver caused by the metacestode. This is exemplified in the territory of Sardinia, Italy where *C. tenuicollis* prevalence of 14.6 % of 30–40-day-old lambs with a total economic cost relating to cysticercosis amounts to almost € 330,000 (Scala et al., 2015). In Iran, *C. tenuicollis* infection rates of 12.87% of slaughtered sheep and 18.04% of slaughtered goats were reported (Radfar et al., 2005), and majority of the cysts were in the omentum. Similarly, prevalence rates of *C. tenuicollis* in slaughtered pigs, goats, and sheep of 6.6%, 45.7% and 51.9%, respectively were reported in Mbeya, Tanzania; 80% of cysts on omentum and 20% on liver; and the metacestodes were confirmed by DNA sequencing of the mitochondrial cytochrome c oxidase subunit 1 gene (cox1) (Braae et al., 2015). On worldwide occurrence of *T. hydatigena* cysticercosis, pigs had higher prevalence in Asia 17.2% (95% CI: 10.6–26.8%) and South America 27.5% (CI: 20.8–35.3%), compared to a low prevalence of 3.9% (95% CI: 1.9–7.9%) in Africa; while cattle had low overall prevalence mean of 1.1% (95% CI: 0.2–5.2%) (Nguyen et al., 2016). In the United Kingdom, 11.3% of dogs are reported infected with *Taenia hydatigena* (Edwards et al., 1979).

d) *Taenia Multiceps (STN. Multiceps Multiceps Coenurus Cerebralis, Taenia Skrjabini, Coenurus Skrjabini, Taenia (Multiceps) Gaigeri, Coenurus Gaige)*

Adults are 40–100 cm long with a small head about 0.8 mm in diameter, four suckers and a double ring of 22–32 rostellar hooks. The large hooks are between 157 and 177 μm long, while the small hooks are 98- 136 μm in length (Loos-Frank, 2000). The proglottids have irregularly alternating genital pores, numerous testes (284 - 354) in a single anterior field and are lateral and posterior to female organs. The

vitelline gland is simple and is situated posteriorly to the ovary, which is bilobed (Khalil, Jones, & Bray, 1994). Mature gravid proglottids are 8–12 mm by 3–4 mm in size with a uterus of 18–26 lateral branches each containing eggs (Khalil et al., 1994). The zoonotic metacestode larval stage (Coenurus cerebralis) is a large fluid-filled cyst up to 5.0 cm or more in diameter with clusters of invaginated scolices (several hundreds) on its internal wall (Taylor et al., 2015).

Life Cycle

The indirect life cycle involves definitive hosts (dogs, foxes, wild canids) and intermediate hosts (cattle, goat, sheep, pig, horse, deer, camel and humans. Infective detached gravid proglottids release eggs discharged with feces from dogs that are ingested by intermediate hosts including humans through contaminated food or water (Craig et al., 2007). Released oncospheres in the small intestine penetrate the intestinal mucosa and blood vessels and travels to the brain or spinal cord through the bloodstream. It takes 2–3 months for the oncospheres to grow into mature coenurus cerebralis cysts (Wu et al., 2012). Cysts can also localize in goats subcutaneous and intramuscular tissues. Infected sheep and goats are lifetime cysts reservoirs (Taylor et al., 2015). The lifecycle is completed when tissues of infected sheep or other livestock are ingested by a definitive host where the parasites in the small intestines develop into adult tapeworms (Varcasia et al., 2009).

Epidemiology

Coenurus cerebralis frequently causes the death of infected animals and can lead to huge economic losses of sheep and goats in many countries within Africa and southeast Asia (Sharma & Chauhan, 2006). The parasite also causes infections in humans leading to serious pathological conditions (Mahadevan et al., 2011; Sharma & Chauhan, 2006). The cysts cause increased intracranial pressure leading to clinical signs such as ataxia, hypermetria, blindness, head deviation, headache, stumbling and paralysis (Abo-Shehada et al., 2002; Bussell et al., 1997).

By virtue of the predilection sites of *Taenia gaigeri* metacestodes in the subcutaneous and muscular tissues and other visceral organs of goats and sheep without harboring in the brain and spinal cord, it has been considered as a distinct species different from *Taenia multiceps* (Schuster et al., 2015). However, this assertion has not been totally accepted. Ahmad Oryan et al. 2015) demonstrated all cerebral and non-cerebral samples obtained from experimental infection were 100% identical to each other and their original source and concluded that *T. gaigeri* may not be a distinct species separate from *T. multiceps*. Similarly, T. skrjabini and *T. gaigeri* are considered synonyms of *Taenia multiceps*.

Genetic variants in *T. multiceps* have been investigated and reported worldwide. Analysis of 233 partial cytochrome oxidase subunit I nucleotide sections for *T. multiceps* revealed high haplotype and low nucleotide diversities. Fifty-one haplotypes were detected circulating in 6 geographic populations. China, Iran, and Turkey had 2 major haplotypes, whereas Italy and Egypt shared 3. Haplotypes from Greece circulate worldwide and displayed similar gene flow values when compared with the other populations (Abbas et al., 2022).

The pooled global prevalence of 5.8% (95% CI 4.7–6.9%) of *Taenia multiceps* in dogs showed highest prevalence (9.1%, 6.5–11.7%) in Asia followed by Europe (5.1%, 3.3–6.9%), Africa (4.2%, 2.9–7.5%) and the least from the Americas (3.3%, 1.3–5.3%) (Abbas et al., 2022).

e) Taenia Ovis (SYN. *Taenia Cervi, Taenia Krabbei, Taenia Hyaenae*)

Adult tapeworms are large, measuring 0.5–1.5 m in length, with rostellum having 24–36 hooks. The strobila has a scalloped edge and is often coiled into a spiral. The mature proglottids have a vaginal sphincter and the ovary and vagina cross each other. The uterus of the gravid proglottids has 20–25 lateral branches on either side (Taylor et al., 2015). Cysts localize in the cardiac and skeletal muscle of sheep, and the evaginated metacestode has four suckers and scolex with approximately 23 hooks (Shi et al., 2016).

Life Cycle

The definitive hosts of this worm are most commonly dogs and sometimes cats and foxes maintaining the adult stage in the small intestines (DeWolf et al., 2013; Jenkins et al., 2014). Gravid proglottids are excreted by the host with over 80,000 eggs per proglottid per day into the environment (Soulsby, 1968). Sheep, goats, and other small ruminants are infected during grazing by eating infective eggs. In the intestine, the oncosphere is released and, through blood circulation, reaches the liver, heart, lungs, spleen, muscles, and other organs, and develops into a cysticercus within three months. These cysts are 6-100 mm in diameter, oval, thin, fluid-filled, and contain a scolex (Soulsby, 1968). The cysts remain viable for only a short period of time, approximately 6 weeks, after which the larva dies, and the cyst becomes calcified and can remain in the tissue for the remainder of the host's life (Rickard & Bell, 1971). The definitive host becomes infected by eating small ruminant viscera with live cysts that grows into adult worm that produces gravid proglottids completing the life cycle (Zheng, 2016).

Epidemiology

Taenia ovis also known as *Cysticercus ovis* or 'sheep measles', occurs throughout much of the world, including New Zealand, Australia, Canada, some African and European countries (Petersen et al., 2008). The first outbreak of *T. ovis* infection in sheep has been reported in Jingtai county, China that affected 58.8% of the animals on the farm (Shi et al., 2016). *Taenia ovis* was also identified from samples collected from 60 wild canids, 57 red foxes (*Vulpes vulpes*) and three wolves (*Canis lupus italicus*) in the Emilia-Romagna region, Italy (Fiocchi et al., 2016).

Infection of small ruminants with *T. ovis* has no clinical signs in infected animals but the presence of viable or calcified cysts in meat and other organs of sheep and goats result in condemnation of the organs or even the entire carcass at post-slaughter inspection (Hajipour et al., 2020).

Meat inspection in the Najafabad slaughterhouse in Isfahan Iran showed *T. ovis* prevalence of 2.9% in sheep and 1.2% in goats, and the prevalence was significantly higher in animals less than one year ($p < 0.0001$), and higher in spring in sheep (8.2%) and goats (2.2%), with an estimated economic loss of US$4167 (Hajipour et al., 2020); and 1.3% in sheep slaughtered in Kermanshah (Hashemnia & Frajani Kish, 2016); and 0.1% in sheep slaughtered in Fars Province (Oryan et al., 2012). Other reported prevalence rates are 3.4% in sheep in Tasmania; and 26% in eastern Ethiopia (Phythian et al., 2018; Sissay et al., 2008); 0.3-3.9% in local goats and 1.7–5.3% in imported goats in Saudi Arabia; and 22% in goats in eastern Ethiopia (Bakhraibah & Alsulami, 2018; Sissay et al., 2008).

f) Taenia Pisiformis (SYN Cysticercus Pisiformis)

Adult worms measuring about 2 m long, have a large scolex with narrow strobila and the rostellum with double rows of 34– 48 hooks. Gravid segments have a uterus with 8–14 lateral branches on either side. The cysticercus is a small pea-like transparent cyst and usually occurs in bunches (Taylor et al., 2015)

Life Cycle

Infections in the definitive canine hosts occur when they ingest the internal organs of lagomorphs infected with *T. pisiformis* metacestodes, each of which can develop into an adult worm in the intestines of dogs. After worm maturation, eggs are released into the environment with the detached proglottids in the host's feces. The prepatent period in the dog is around 6–8 weeks. The intermediate hosts (rabbits) become infected when they consume feed and water contaminated with the egg (Foronda et al., 2003; S. Zhang, 2019). Ingested eggs hatch in the small intestine of the intermediate host and penetrate the intestinal wall and pass via the portal system to the liver. Juvenile stages migrate through the liver parenchyma and locate in the abdominal cavity after 2–4 weeks, where they develop into cysts (Cysticercus pisiformis) attached to the wall of the mesentery and omentum (Taylor et al., 2015).

Epidemiology

The worm is distributed worldwide. In China, *T. pisiformis* is a common parasite that infects rabbits. The larvae can cause severe health problems in rabbits, such as liver lesions, digestive disorders, and secondary bacterial infection, resulting in economic losses in the rabbit breeding industry (Zhou et al., 2008). However, due to the absence of effective vaccines and deworming drugs, the parasitic disease is not currently well controlled (Zhang, 2019).

g) Taenia Saginata (SYN. Taeniarhynchus Saginata, Cysticercus Bovis)

Adult tapeworms are 5–8 m long, with scolex devoid of rostellum and hooks. Mature gravid segments are 16–20 mm long by 4–7 mm wide and the uterus has 15– 35 lateral branches on either side. The mature *Cysticercus bovis* is greyish-white, oval, about 0.5–1.0 by 0.5 cm long, and filled with fluid in which the scolex without rostellum and hooks is usually visible (Taylor et al., 2015).

Life Cycle

The lifecycle is indirect involving humans as definitive host and cattle as intermediate host. Infected humans may discharge millions of eggs daily, either free in feces or as detached proglottid segments each having about 250,000 eggs. Following eggs ingestion by cattle, the liberated oncosphere travels via the blood to striated muscles and takes about 12 weeks to develop into infective metacestode that remains viable for many weeks or years. Both living and dead cysts are often present in the same carcass. Humans become infected by ingesting raw or undercooked beef. Development to patency takes 2–3 months in the small intestine (Taylor et al., 2015).

Epidemiology

Taenia saginata is a cosmopolitan zoonotic tapeworm which is highly endemic in Africa, Asia, Latin America, and some other countries, where humans and domestic animals live together under poor sanitary conditions and where raw/undercooked beef is consumed (Pawlowski & Schultz, 1972). It is still prevalent in Europe and causing economic losses due to condemnation, refrigeration and downgrading of infected bovine carcasses. Its persistence is associated to the low sensitivity of current meat inspection protocols; dissemination and survival of eggs in the environment, and cattle husbandry systems that allow grazing on pastures and drinking from water streams (Dorny & Praet, 2007).

Humans infected with adult tapeworm release the worm eggs into the environment through their feces. Transmission to cattle occurs through the contamination of pasture, fodder or water with eggs which are viable for several weeks or months. Direct transmission of eggs through hand raising of suckling calves by tapeworm carriers has been reported but appears to be rare (Murrell, 2005).

When cattle ingest the worm eggs, the oncospheres hatch and migrate through the blood to skeletal and cardiac muscles where they develop into infective cysticerci to humans in about 10 weeks. Cysts in cattle degenerate within a few months and by 9 months a substantial proportion of them are dead and calcified (Dorny & Praet, 2007; Flisser et al., 2005).

h) Taenia Serialis (SYN. Multiceps Serialis, Coenurus Serialis)

Adult tapeworm is about 0.5 – 0.7 m long, and the scolex is armed with two rows of 26 – 32 hooks. The gravid uterus has 20 – 25 lateral branches on either side. The metacestode cysts may be 4 – 6 cm in size and the scolices are distributed in packed rows within the cyst (Taylor et al., 2015).

Life Cycle

The indirect life cycle involves dogs and foxes as definitive hosts and rabbits and hares as intermediate hosts. Infection of the rabbits is through ingestion of the worm eggs shed by dogs. The intermediate stage, Coenurus serialis, is found in the rabbit, usually subcutaneously or in the intermuscular connective tissue. Coenurus is a fluid-filled cyst with many invaginated scolices surrounded by a fibrous capsule formed by the intermediate host. The final host is infected by ingesting the metacestode that grows into adult worm in the small intestines (Bowman, 2020; Taylor et al., 2015).

Epidemiology

The Coenurus of *Taenia serialis* is reported to have caused exophthalmos in domestic rabbits in Australia (Bethell & Truszkowska, 2010). Rabbits get infected through eating grass contaminated with worm eggs from dogs, or indirectly from grass contamination through wind, rain, birds, and arthropods acting as vectors dispersing the eggs (Dunsmore & Shaw, 1990). Coenurus of *T. serialis* was also reported in the internal abdominal muscles of wild rabbit carcass found in the Qinghai Tibetan Plateau, China (Zhang et al., 2018).

Coenurosis of *T. serialis* is zoonotic when humans are accidentally infected by ingesting eggs through contaminated water, fruits, or vegetables (Benger et al., 1981). Clinical manifestation of seizures, ataxia and other neurological signs are seen in humans with coenurosis involving the central nervous system. The first proven human coenurosis occurred in a 59-year-old French woman in 1933, followed by another case in a two-year old California boy in 1950 (Zhang et al., 2018); and more recently a Nigerian man with larvae in the subcutaneous tissue of the lower jaw (Tappe et al., 2016).

i) Taenia Solium (SYN. *Cysticercus Solium*)

Adult worms are 3–8 m long with a rostellum, four radially arranged suckers, and 22–32 hooks arranged in two rows: one row of large hooks measuring 0.14–0.18 mm and one row of smaller hooks measuring 0.11–0.14 mm. It has a narrow neck, and a large strobila measuring 2–4 m and consisting of several hundred proglottids. Mature gravid segments are 10–12 mm long and 5–6 mm wide. The ovary is in the posterior third of the proglottid and has two lobes with an accessory third lobe. The uterus has 7–16 lateral branches on either side with dendritic pattern (García et al., 2003; Taylor et al., 2015).

The cysticercus comes in two forms. The most common 'cellulose' form has a 0.5–1.5 cm long fluid-filled bladder with an invaginated scolex. The 'racemose' form is larger, about 20 cm long with no distinct scolex (Taylor et al., 2015).

Life Cycle

This zoonotic worm has an indirect life cycle involving humans as the only definitive host of the adult worm and acting as intermediate host with pigs for the cysticercus stage. Adult worms release gravid proglottid segments excreted by the host with feces in chains, each having around 40,000 eggs, concentrated over a small area. Eggs could resist destruction in the environment for a relatively prolonged period. After ingestion by a susceptible pig the oncosphere traverses the gut wall into the blood and develops into cysticercus mainly in striated muscles but also in the lungs, liver, kidneys and brain. Humans become infected by ingesting raw or inadequately cooked pork having viable cysticerci which grow into adult tapeworms in the small intestine. The prepatent period is 2 – 3 months (Taylor et al., 2015).

The human final host may also function as an intermediate host and become infected with cysticerci. This is most likely to occur from the accidental ingestion of *T. solium* eggs via unwashed hands or contaminated food. There is also a minor route of autoinfection in a person with an adult tapeworm, from the liberation of oncospheres after the digestion of a gravid segment that has entered the stomach from the duodenum by reverse peristalsis (Taylor et al., 2015).

Epidemiology

Taenia solium taeniosis-cysticercosis infection is prevalent worldwide, but higher in areas where sanitation is a major challenge, and pig production and processing are still extensively managed. Endemicity of this disease in many Latin American, African, and Asian countries is associated to poverty, ignorance, lack of suitable diagnostic and management capacity and appropriate prevention and control strategies (Torgerson & Macpherson, 2011). Significantly higher porcine cysticercosis seroprevalence has been found in communities practicing open defecation than those that do not (Secka et al., 2010). Similarly, higher seropositivity for human cysticercosis are significantly associated with open defecation, older age group and presence of tapeworm carriers (Nguekam et al., 2003; E Sarti et al., 1994; Elsa Sarti et al., 1992; Secka et al., 2011).

Generally, cysticercosis leads to high economic burden linked to pork production losses, high hospitalization costs and reduced productivity for persons with neurocysticercosis (Pawlowski et al., 2005). Increasing numbers of autotochtonus and imported cases of cysticercosis are being reported In Europe, United States of America, Australia, and Kuwait (Pawlowski et al., 2005; Shandera et al., 2002; Zammarchi et al., 2013).

About 2.5 million people are infected with *T. solium*, and there are 50,000 deaths annually due to neurocysticercosis (Pawlowski et al., 2005). Neurocysticercosis is also the leading cause of epilepsy in many low- and medium-income countries, contributing up to 30% of epilepsy cases in endemic areas, with an estimated disease burden of 2–5 million loss in disability-adjusted life years (DALYs) (Torgerson & Macpherson, 2011).

Taenia solium in pork is ranked first food-borne parasite of public health concern during a joint FAO/WHO expert meeting in 2012. Furthermore in 2015, it has been identified as a leading cause of deaths from food borne diseases with a total of 2.8 million disability-adjusted life-years (DALYs). Major contributors of these DALYs are from Africa, South America, and Southeast Asia (WHO, 2016).

j) Taenia Taeniaeformis (Syn. Hydatigera Taeniaeformis, Taenia Crassicollis, Strobilocercus Fasciolaris, Strobilocercus Crassicollis, Broad Neck Tapeworm)

The adult tapeworm measures up to 70 cm long, has a large scolex with a double row of rostellar hooks and no distinct neck region. The neck is broad as the scolex, and segmentation begins immediately behind the scolex. The scolex has a large double circlet of 30 to 40 hooks and four clearly lateral suckers. The large hooks are arranged with double and alternating circlet of hooks measuring 0.36 - 0.44 mm for the anterior crown and 0.25 - 27 mm for the posterior one (Al-Jashamy & Islam, 2007). The uterus has five to nine lateral branches and the posterior proglottids are bell-shaped (Taylor et al., 2015).

The metacestode stage is a strobilocercus (Strobilocercus fasciolaris), which is a small cyst connected with an evaginated scolex by a segmented juvenile strobila (Taylor et al., 2015).

Life Cycle

Eggs from the adult worm are ingested by the intermediate host along contaminated feed or water. Hatched oncosphere develops to metacestode in the

liver of rodents and infective to definitive host after about 9 weeks. When a cat ingests rodents with infective metacestode, the scolex attaches to the wall of the intestine and develops into adult tapeworm. Cats begin shedding worm eggs 6 weeks after ingesting the metacestode and could remain infected for up to about 2 years (Taylor et al., 2015).

Epidemiology

This zoonotic parasite has a cosmopolitan geographic distribution. Adults occur in small intestines of definitive hosts which are carnivores of the families Felidae, Canidae and Mustelidae, including domestic cats and dogs (Nichol, et al., 1981). The intermediate hosts are mouse, rat, cat, muskrat, squirrel, rabbit, other rodent, bat, and human harboring the larval stage *Cysticercus fasciolaris* in the liver. They get infected through water or feed materials contaminated with infected cat feces. Sporadic larval infection cases in human were reported from Argentina, Czechoslovakia, Denmark, and Taiwan (Ekanayake et al., 1999; Nichol et al., 1981). Occurrence of *Strobilocercus fasciolaris* in the liver of man found during postmortem has been reported in Europe (Stĕrba & Barus, 1976).

III. Clinical Signs

a) Taeniosis

Human taeniosis arising from infection with adult *Taenia asiatica, T. saginata,* and *T. solium* are generally clinically inapparent (Dorny et al., 2005); however, infections with *T. saginata* could sometimes be associated with loss of appetite and diarrhea (Kaufmann, 1996). Anal pruritus, mild abdominal pain, nausea, change in appetite, weakness, weight loss, headache, constipation, dizziness, and diarrhea have also been reported (Silva & Costa-Cruz, 2010).

Dogs, foxes, wild canids, and wild felids infected with adult tapeworms do not manifest clinical signs.

b) Human Cysticercosis

Human cysticercosis are associated with infections caused by larval metacestode forms of *Taenia solium, T. serialis, T. crassiseps,* and *T. multiceps* all affecting the brain leading to neurocysticercosis or coenurosis; whilst *T. taeniaformis, T. serialis,* and *T. crassiseps* are reported to affect the liver, subcutaneous tissue, muscle, eye, and upper limb. People with neurocysticercosis may either show no clinical sign for life or manifest epileptic seizures, headaches with or without accompanying intracranial hypertension, focal neurological symptoms, and cognitive disabilities (Garcia et al., 2014). Coenurosis signs include seizures, ataxia, hypermetria, blindness, head deviation, headache, stumbling and paralysis (Abo-Shehada et al., 2002).

c) Animal Cysticercosis

Animal cysticercosis are associated to the larval metacestode forms of *T. saginata* and *T. hydatigena* in cattle*; T. solium*, *T. asiatica* and *T. hydatigena* in pigs; *T. ovis, T. multiceps* and *T. hydatigena* in sheep and goats; and *T. pisiformis* and *T. serialis* in rabbits. They mostly affect muscle, liver, lungs, omentum, peritoneum, subcutaneous tissue, heart, eye, and brain. Infections are mostly asymptomatic and usually detected during meat inspection after slaughter or during necropsy. *Coenurus cerebralis* causes death in sheep when localized in the brain. Cysticercosis in animals causes economic losses due to condemnation of parts or whole carcasses. Exophthalmos has been reported in rabbit eyes. *Taenia pisiformis* larvae are reported to cause severe health problems, liver lesion, digestive disorders, secondary bacterial infections leading to economic losses in the rabbit industry in China (Zhou et al., 2008).

IV. Lesions

Adult tapeworms are often found in the lumen of the small intestines of the definitive hosts during necropsy.

Cysticerci infections in the intermediate hosts manifest macroscopic lesions which varies depending on the worm species and their predilection sites. For example *Taenia hydategenia* cysticerci in lambs caused hepatic fibrotic foci, open pits in the liver capsule, and presence of the metacestodes within hemorrhagic streaks in the liver parenchyma, abdominal fluid, omentum; and adhesions and ribbons of fibrotic tissue involving the liver and diaphragm or omentum and body wall (Sweatman & Plummer, 1957).

Human neurocysticercosis arising from *T. solium* infection are characterized by presence of viable or degenerative cysts, immune system induced granuloma formation and prelesional edema, and residual calcified cysts in the brain (Garcia et al., 2018).

V. Diagnosis

Adult tapeworm infections could be identified by microscopic examination of stool and anal swab samples using sedimentation and concentration techniques, although it may not directly differentiate the eggs at species level. Expelled gravid proglottids found on beds or in underwear or whole worm with scolex could also be examined microscopically to identify the species. Coprological evaluation is the most traditional and widely used method for diagnosing tapeworm infections, but it is less sensitive and specific.

Taenia eggs are oval to spherical in shape, containing oncospheres covered with a thick wall embryophore, and measuring 34 – 39 x 31 – 38 μm (Kaufmann, 1996). Research is undertaken to advance diagnostic tools for differentiating taenia eggs at species

or sub-species level using morphologic criteria and molecular techniques. Detailed morphologic examination of the proglottid segments and eggs could ease species identification. Ziehl-Neelsen staining, egg shape and size have been found to be highly specific and varying sensitivity to differentiate taenia eggs and proglottids of *T. solium* and *T. saginata* (Jimenez et al., 2010).

Porcine and bovine cysticercosis are detected during meat inspection at animal slaughterhouses. Light infections could be difficult to detect by meat inspection, but heavy infections are characterized by macroscopic presence of cysts in the muscles of the carcass and visceral organs.

Serological techniques are developed for evaluating the presence of antibodies against taenia spp. or antigens of taenia spp. in fecal, serum, cerebrospinal fluid, and saliva samples from both humans and animal species. These include enzyme linked immunosorbent assay (ELISA) for copraantigen testing (gold standard), antibody and antigen ELISA, Compliment Fixation test, haemagglutination, latex agglutination, radioimmunoassay, and electroimmuno-transfer blot (EITB) (Flisser et al., 1990; Mayta et al., 2008). ELISA techniques are limited by cross-reactions of different taenia species.

Molecular diagnostic tools are also being developed with greater sensitivity and specificity for identifying taenia species. The widely used techniques include Nested PCR, Multiplex PCR, species specific oligonucleotides multiplex PCR, and RNA sequencing of single tapeworm egg isolates from stool samples (González et al., 2000; Jeon et al., 2009; Sadlowski et al., 2021).

Imaging techniques are also used solely or as a conjunct to clinical, microscopy, serology, and molecular tools for the confirmation of neurocysticercosis or extraneural human and animal cysticercosis cases. The widely used tools include radiography, computerized tomography scan, and magnetic resonance imaging. Histologic examination of biopsy samples is also used for examining cysticerci cysts.

VI. Treatment

The adult tapeworm human and animal carriers are cured by anthelminthic drugs such as albendazole, oxfendazole, niclosamide, and praziquantel. In addition, Yomensan is the drug of choice for treating *T. saginata* infection in man (Pawlowski & Schultz, 1972). The treatment and management of cysticercosis including neurocysticercosis in humans is thoroughly described in the 2005 WHO/FAO/OIE Guidelines on Taeniosis/ cysticercosis (Murrell et al., 2005). Depending on the location, severity, and inflammatory reaction to the cysticerci, the groups of medications they listed for use include analgesics, anti-inflammatory, antiepileptic

drugs, corticosteroids, praziquantel, albendazole, or surgery interventions.

Porcine cysticercosis is treatable by oxfendazole. Oxfendazole is shown to have 100% efficacy in curing porcine cysticercosis for a duration of 3 months after its administration (Gonzales et al., 2001).

Heavily infected bovine and porcine carcasses are usually condemned, buried, or incinerated when detected during meat inspection. The lightly infected carcasses could be treated through freezing, boiling, or pickling in common salt (Murrell et al., 2005).

VII. Control and Prevention

The goal of controlling and preventing taenia infections in humans and animals is to break the cycle of transmission between the intermediate and final host through various interventions that significantly reduce the risk of acquiring taeniosis and cysticercosis. Although *Taenia solium, T. saginata, T. serialis, T. crassiceps, T. taeniaformis,* and *T. multiceps* are all zoonotic parasites affecting humans, *T. solium* is the most important species receiving global attention due to its greater negative impact on human health than the other taenia species.

General intervention strategies for the control and prevention of taenia infections as described in the WHO/FAO/OIE Guidelines on Taeniosis/cysticercosis (Murrell et al., 2005) are as follows:

1. Meat inspection to prevent human infection. Inspection of cattle, sheep, goats and pig carcasses at abattoirs helps identify metacestode infected carcasses that could be condemned and destroyed or treated thus eliminating the risk of infecting humans. Limitations to this intervention are the low sensitivity in detecting mildly infected carcasses, absence of meat inspection in many rural endemic areas, and the sales and consumption of meat that has not passed through official meat inspection processes.

2. Control of cattle and pig marketing. The marketing of infected life animals and carcasses by farmers and traders could potentially lead to transmission of the disease through maintenance of its lifecycle. Central and local governments need to develop strategies, regulations, penalties, and incentives for controlling the marketing of cattle and pigs to ensure reduced risk of disease transmission in disease endemic communities. Enforcing marketing control strategies remains a challenge to overcome the implementation of control programs.

3. Improve farm management to prevent cattle and pigs accessing human feces. Raising animals in confined areas and preventing them access to human feces would greatly reduce the risk of ingesting taenia eggs found in human feces. Sustained implementation in poor rural endemic communities is still a big challenge to overcome.

Sustained implementation in poor rural endemic communities is still a big challenge to overcome.

4. Vaccination of pigs against *T. solium* infection. Injectable TSOL18 (cysvax™) vaccine has been licensed for use in pigs by India since 2016. Concurrent administration of oxfendazole treatment and TSOL 18 vaccination has been found highly effective in reducing porcine cysticercosis in Uganda (Nsadha et al., 2021), Tanzania (Kabululu et al., 2020), Cameroon (Lightowlers & Donadeu, 2017), and Nepal (Poudel et al., 2019). Orally administered vaccines (S3Pvac and S3Pvac-phage) have also proven effective in reducing porcine cysticercosis (Morales et al., 2011). When oral vaccines become operationalize, it will be much easier to administer thus reduces costs and ease implementation of vaccination programs.

5. Screening and treatment of farm workers and tapeworm carriers at endemic community settlements. This intervention requires a one-health approach involving veterinary and medical professionals working together to control a zoonotic parasite. Administration of niclosamide or praziquantel is effective in treating human tapeworm carriers. This would reduce the transmission of taenia eggs into the environment that could eventually be ingested by cattle, pigs and humans leading to cysticercosis. The major challenge in underdeveloped rural communities is detecting tapeworm carriers as no major clinical signs are manifested by persons with taeniosis and health posts are ill equipped to diagnose taenia infections in humans. Infection in pigs may also go unnoticed in the absence of official meat inspection or disease surveillance programs.

6. Improved sanitation. Open air defecation by humans in areas where sanitary facilities are not available poses risk to roaming pigs and cattle for contracting cysticercosis. Provision of latrines in rural areas and improved sewage system in urban areas would decrease exposure to human feces which is a risk factor for cysticercosis transmission in cattle and pigs.

7. Proper treatment of sewage and sludge to kill taenia eggs. The presence of viable taenia eggs in sewage and sludge is still a risk to animals and humans when pasture, feed and drinking water for animals are contaminated as well as human food and water becoming contaminated.

8. Health education. Educating people at high risk of contracting taenia infection would facilitate implementation of control interventions. Public awareness of taenia lifecycle, disease manifestations, and the negative economic impact on livestock production, high hospital cost and losses in disability-adjusted life years (DALYs) associated with neurocysticercosis, could trigger attitudinal changes that could break the disease transmission in highly endemic areas.

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Socio-Economic Profile of Dairy Farmers in Maharashtra: A Case Study of Latur District

By Dr. Kiran Dilip Khalangre & Dr. M. V. Suryawanshi

Dr. Babashaheb Abedkar Marathwada University

Abstract- If we look at the state's population growth patterns, milk and milk products must be used to ensure both food security and nutritional security. Another possibility is that the populace expresses various concerns like food insecurity, perceived insecurity, unemployment, etc., and the government responds by taking quick and effective action to address these concerns. The current study examines various facets of dairy farming and the current state of milk production, consumption, and sales. The city of Latur was deliberately chosen for the investigation. Two tehsils were randomly chosen from the zone, and two blocks were randomly chosen from each tehsil. Each block has two villages drawn at random. 10% of dairy producers were chosen proportionately and randomly from among all the households in each community.

Keywords: dairy farmers, socio-economic profile, occupation, rural development.

GJSFR-D Classification: *LCC: S1-972*

SOCIOECONOMICPROFILEOFDAIRYFARMERSINMAHARASHTRAACASESTUDYOFLATURDISTRICT

Strictly as per the compliance and regulations of:

Socio-Economic Profile of Dairy Farmers in Maharashtra: A Case Study of Latur District

Dr. Kiran Dilip Khalangre ^α & Dr. M. V. Suryawanshi ^σ

Abstract- If we look at the state's population growth patterns, milk and milk products must be used to ensure both food security and nutritional security. Another possibility is that the populace expresses various concerns like food insecurity, perceived insecurity, unemployment, etc., and the government responds by taking quick and effective action to address these concerns. The current study examines various facets of dairy farming and the current state of milk production, consumption, and sales. The city of Latur was deliberately chosen for the investigation. Two tehsils were randomly chosen from the zone, and two blocks were randomly chosen from each tehsil. Each block has two villages drawn at random. 10% of dairy producers were chosen proportionately and randomly from among all the households in each community. Dairying was the primary occupation of 12.81% of the respondents, whereas the major occupations of 8.75%, 7.18%, and 4.68% of the respondents were business, labour, and services, respectively. In contrast, the majority of respondents (64.68%) chose dairying as their secondary occupation, followed by agriculture (22.81%) with 20.00% of the respondents. The respondents stipulated that at the time of the inquiry, dairy farmers had to have at least one lactating dairy animal. The majority of respondents (45.93%) sold 4 to 7 liters of milk per day, followed by 40.31% and 13.75 % of respondents who sold less than 4 liters and more than 7 liters of milk, respectively. In the study region, agriculture was the main industry and dairying was the secondary one. As increased milk production was the farmers' primary goal, respondents had more crossbred cattle and buffalo than native livestock. Farmers often sell their milk in cooperative societies, while some also sell in independent shops.

Keywords: dairy farmers, socio-economic profile, occupation, rural development.

I. Introduction

India is primarily an agricultural country, with animal husbandry serving as the foundation of the economy. Next to agriculture, the dairy industry not only boosts family nutrition standards and continuously generates cash, but it also partially lowers unemployment (Kumar, 2020). More than 80 percent of all agricultural workers are employed in the dairy sector. Dairy farming is currently a significant source of livelihood in India, giving farmers a steady stream of cash and eventually assisting in improving the socioeconomic situation of rural people. The socioeconomic makeup of the dairy producers reflects the way the local social dynamics shape the economic activities. As a result, it is seen as a crucial prerequisite for making decisions that eventually have an impact on the profitability of any economic organization (Mohapatra, 2021). For small farmers, marginal farmers, and agricultural laborers in the state, dairy production is a significant source of supplemental revenue. For low- and moderate-income households, dairy farming plays a significant part in both commercial and subsistence farming. The dairy industry has a lot of promise for improving the socioeconomic circumstances of small, marginal farmers and agricultural employees since it produces more and makes profits faster than other businesses. In a shorter amount of time, it has increased the state's income, the creation of jobs, and the labor force. In Latur, dairy farmers raise lactating animals to generate income that is complementary to crop farming. If we look at the state's population growth patterns, milk and milk products must be used to ensure both food security and nutritional security. Another possibility is that the populace expresses various concerns like food insecurity, perceived insecurity, unemployment, etc., and the government responds by taking quick and effective action to address these concerns (Wetal, 2023) .His paper depicts the socio-economic profile of dairy farmers and the constraints experienced by them during dairy farming in the Latur district of Maharashtra.

II. Study Area

Latur district is in the Marathwada region in Maharashtra in India, located between 17°52' to 18°50' latitudes North and between the 76°18' to 79°12' longitudes East in the Deccan plateau. The district is situated on the Maharashtra Karnataka boundary on the eastern side of the Latur is Bidder district of Karnataka, whereas Nanded is on the Northeast, Parbhani on the Northern side, and Beed on the Northwest and Osmanabad on the Western and Southern side. The entire district of Latur is situated on the Balaghat Plateau, 540 to 638mts from the mean sea level.

III. Objectives

- To study the socio-economic and personal characteristics of dairy farmers.
- To find out the knowledge of improved dairy management practices.

Author α: Assistant Professor Dept. of. Geography, Dr. Babashaheb Abedkar Marathwada University, Aurangabad.
Author σ: Head Dept. of Geography Dr. Babashaheb Abedkar Marathwada University, Aurangabad.
e-mail: kirankhalangrereddy@gmail.com

- To highlight facilitating factors that could help promote dairy development to improve

IV. Material and Methods

The purpose of the study was to investigate the various facets of dairy farming as well as the utilization and sales of milk. The Latur district was purposefully chosen for the study. Two tehsils were randomly chosen from the zone, and four blocks were chosen at random from the tehsil. Each block has two villages drawn at random. Out of all the farmers in each community, 10% of them were dairy producers, chosen proportionately and randomly. Thus, 320 samples were taken in total. According to the requirements of the responders, dairy farmers must have at least one dairy cow that is nursing at the time of the research. A structured interview schedule that was created for this purpose served as the main method of data collecting. Age, education, family size, herd size, operational land holding, annual income, dairying experience, milk output, milk use, milk sale, social participation, one-on-one interaction, personal cosmopolite, and media exposure were among the study's variables. Utilizing straightforward statistical tools like frequency and percentage, the acquired data was examined.

V. Results and Discussion

a) Age

Results in Table 1 show that the majority of the dairy farmers belonged to the middle age group (50.93 %), and 26.87 percent of farmers have the old age group. The remaining 22.18 percent of farmers have young age. These results indicate that middle-aged farmers take up dairying as income generating activity as they are more capable physically and could shoulder more family responsibilities. Almost similar findings were observed by (Rahul Choudhary, 2018) who found that the majority of the respondents belong to medium age group.

b) Family Size

According to the distribution of respondents (Table 1), it was observed that most (48.12 %) of the respondents belonged to the medium family size (5-7 members), followed by small family size (less than 5 members), accounting for 21.56 percent and lastly large family size (>7 members), accounting for 30.31 percent of respondents. These findings are in agreement with the findings of (Subhash Kumar Saurav, 2023), as they also reported that the majority of the respondents belonged to medium family size.

c) Education

When evaluating dairy farmers' knowledge and capacity to adopt sound farming practices, their educational background is a crucial factor. Table: 1's perusal revealed that the bulk of respondents (24.37%) had completed middle-level education, while 29.68 percent had completed secondary education. In addition, it was discovered that 16.56% and 14.68 %, respectively, of the respondents, had degrees from secondary and primary education levels. 10.31 percent of respondents, or more than one-tenth, had graduated from high school or above. 4.37%, respectively, of the respondents, fell into the illiteracy category (Prashad, 2019). The study found that the majority (68.75 %) of dairy farmers had a high school diploma or more, followed by intermediate (16.56 %) and middle school (24.37%).

d) Occupation

The occupations of the respondents were divided into Primary and Secondary occupations wherein the primary occupations, contributes to more than 50 percent of the annual income of the respondents.

e) Primary Occupation

From Table 1, it was observed that 66.56 percent of respondents practiced agriculture as their primary occupation, followed by business accounting for 8.75 percent, service accounting for 7.18 percent, dairy accounting for 12.81 percent respondents, lastly, 4.68 percent of respondents practiced labor as their primary occupation. This trend could be due to the limited job opportunities in the area.

f) Secondary Occupation

From Table 1, it was found that the majority (64.68 %) of respondents practiced dairy farming as their secondary occupation, followed by agriculture accounting for 22.81 percent, labor accounting for 6.56 percent, business accounting for 5.93 percent and lastly (A. Rajadurai, 2018) These findings were similar to the findings of, who also reported that majority of the respondents practiced dairy as their secondary occupation.

g) Herd size

From Table 1, it was found that 30.00percent respondents were in the small herd size category (up to 3 animals), followed by medium herd size (3 to 4 animals), accounting for 58.43 percent and lastly, large herd size (Above 6 animals) accounting for 11.56 percent of respondents. This trend could be due to the lower annual income of the respondents and dairy farming is the secondary source of income for most of the respondents. These findings are similar to the findings of (Vekariya et al., 2016) who also reported that the majority of the respondents had small herd sizes.

h) Operational land Holding (OLH)

In this research the actual land possessed by the respondent was indicated. Perusal of Table: 1 found that the majority of the respondents (42.05%) were marginal land Holders which were followed by 30.93 percent and 11.25 percent of the respondents who were

small and landholders respectively? A very less proportion of the respondents (6.87%) had medium land holding followed by 8.43per cent of the respondents who were Land less. None of the respondents had land holding. (Rajadurai et al., 2018) observed that Maximum number of respondents were landless (71.40%), while small farmers (17.70%).

i)   Annual income

According to Table 1, the majority of respondents (57.18%) had medium income levels between 0.75 and 1.5 lakhs, followed by respondents with low-income levels of less than 0.75 lakhs and respondents with high-income levels of more than 1.5 lakhs at 1.87 % and 19.06 %, respectively. (Atreya et al. 2018)

j)   Milk Production

Milk production was calculated in terms of the amount of milk produced in Litre per day basis from the lactating animals. In Table: 1 it was found that majority (41.87%) of the respondents had Lactating animals that produce 5 to 9 liters of milk per day. Dairying on a small scale basis followed by 27.18 % and 30.93 % of the respondents had lactating animals that produce more than 9 liters and less than 5 liters of milk respectively. (Prasad et al., 2017) revealed that the average milk yield of cattle was 69.00 %.

k)   Milk Consumption

The amount of milk drank by the household of the sampler, expressed in liters, and wasused to calculate consumption. Each respondent's daily basis. Table: 1 analysis revealed that just over half (51.56%) of the respondents drank 2 to 3 liters of milk per day, which was followed by respondents who drank less than 2 liters and more than 3 liters of milk on a daily basis for household consumption, respectively, by 35.00 percent and 13.43 percent of the respondents.

l)   Milk Sale

Milk sale was presented as the amount of milk being sold by the respondents on daily basis. A glance at Table: 1 was found that majority (45.93%) of the respondents sold 4to 7 liters of milk per day followed by 40.31 per cent and 13.75 per cent of the respondents who sold less than 5 liters and more than 8 litres of milk respectively. (Koli et al., 2020) revealed that majority of the respondents (82.50 %) had medium level of milk sale category.

m)   Social Participation

According to Table: 1 majority (52.18%) of the respondents had a medium level of social Participation followed by 37.18 percent and10 percent of the respondents who had low and high social participation respectively. Social participation of the respondents was sat is factory because some farmers engaged in

reported that the majority (68.00%) of the respondents had a low level of social participation, followed by 27.00 percent medium level.

n)   Mass Media Exposure

A glance at Table: 1 was found that near about half of the respondents (49.06%) had medium mass media exposure followed by 36.87 percent and 14.06 per cent of the respondents who had low and high mass media exposure respectively because most of the farmers having Smartphone's, internet connection, television etc. (Manjunath et al., 2020) in his study observed that majority (62.00%) of the respondents belonged to medium mass media exposure

VI.   Conclusion

In Latur, small and marginal farmers rely heavily on the money generated by the dairy industry. The majority of responders had a medium level of age, according to the survey. In the study region, agriculture was the main industry and dairying was the secondary one. As increased milk production was the farmers' primary goal, respondents had more crossbred cattle and buffalo than native livestock. Farmers often sell their milk in cooperative societies, while some also sell in independent shops. Respondents had a moderate amount of exposure to the media because the majority of farmers had smartphones, internet connections, televisions, etc. Respondents' social participation was good because some farmers were members of cooperative societies.

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Table 1: Socio-Economic and Communication Respondent (n=320)

Category		Frequency Percentage	Frequency Percentage
Age	Youngage (upto35)	71	22.18
	Middleage(36-50)	163	50.93
	Oldage (above50)	86	26.87
FamilySize	Small(<5)	69	21.56
	Medium(5to7)	154	48.12
	Large(>7)	97	30.31
Education	Illiterate	14	4.37
	Primary	47	14.68
	Middle	78	24.37
	Secondary	95	29.68
	Intermediate	53	16.56
	Graduateandabove	33	10.31
Occupation			
Primary	Agriculture	213	66.56
	Dairying	41	12.81
	Service	23	7.18
	Business	28	8.75
	Labor	15	4.68
Secondary	Agriculture	73	22.81
	Dairying	207	64.68
	Business	19	5.93
	Labor	21	6.56
Herd size	Small(<3)	96	30
	Medium(3to4)	187	58.43
	Large(>4)	37	11.56
Operation all and holding	Landless(0ha)	27	8.43
	Marginal	136	42.5
	Small1-2ha	99	30.93
	Semi-medium2.1-4ha	36	11.25
	Medium4.1-10ha	22	6.87
	Large >10ha	0	0
Annual Income	Low(<0.75 lakh)	76	1.87
	Medium(0.75to1.5lakh)	183	57.18
	High(>1.5lakh)	61	19.06
Milk production	Low(<5)	87	27.18
	Medium(5to9)	134	41.87
	High(>9)	99	30.93

Milk consumption	Low(<2)	112	35
	Medium(2to3)	165	51.56
	High(>3)	43	13.43
Social participation	Low(<3)	121	37.81
	Medium(3to5)	167	52.18
	medium(>5)	32	10
Milk Sale	Low(<4)	129	40.31
	Medium(4to7)	147	45.93
	High(>7)	44	13.75
Mass Media Exposure	Low(<7)	118	36.87
	Medium(7to8)	157	49.06
	High(>8)	45	14.06

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Research Results of a Combined Machine that Increases Productivity in Grain Farming

By Qurbanov Huseyn Nuraddin

Abstract- Fertile and nutritious soil is the main condition for increasing the productivity of cereal crops in agriculture. By adding mineral fertilizers to the soil, nutrients are added to the nutrients in the soil and enrich it by increasing its fertility. Even distribution of fertilizers in the field is one of the main conditions that increase its efficiency. It is not possible to increase the productivity infinitely by increasing the fertilizer rate.

Uneven fertilization significantly affects the characteristics of the crop and causes environmental pollution. The inhomogeneity of the field in terms of nutrients resulting from fertilization is often the main cause of uneven cropping. Cereal plants also cause yield loss, which in some years can reach about 25-60%. Experience in the operation of modern technical means has shown that at present, there is a need to provide an equal amount of fertilizer on the slopes to under the soil, fully meeting the agro-technical requirements.

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GJSFR-D Classification: FOR Code: 0701

RESEARCHRESULTSOFACOMBINEDMACHINETHATINCREASESPRODUCTIVITYINGRAINFARMING

Strictly as per the compliance and regulations of:

Research Results of a Combined Machine that Increases Productivity in Grain Farming

Qurbanov Huseyn Nuraddin

Abstract- Fertile and nutritious soil is the main condition for increasing the productivity of cereal crops in agriculture. By adding mineral fertilizers to the soil, nutrients are added to the nutrients in the soil and enrich it by increasing its fertility. Even distribution of fertilizers in the field is one of the main conditions that increase its efficiency. It is not possible to increase the productivity infinitely by increasing the fertilizer rate.

Uneven fertilization significantly affects the characteristics of the crop and causes environmental pollution. The inhomogeneity of the field in terms of nutrients resulting from fertilization is often the main cause of uneven cropping. Cereal plants also cause yield loss, which in some years can reach about 25-60%. Experience in the operation of modern technical means has shown that at present, there is a need to provide an equal amount of fertilizer on the slopes to under the soil, fully meeting the agro-technical requirements.

As can be seen, the development of a new technical proposal for fertilizing and plowing the slopes in equal amounts on the slopes, improving the technological and design parameters, taking into account the physical and mechanical properties of fertilizers, is very important.

Taking into account the above-mentioned issues, a combined plough was developed in our laboratory. Combined plough carries out pre-sowing technological operation in the cultivation of cereals, providing a smooth equal amount of mineral fertilizers to under the soil on the slopes.

Thus, in the article, the optimal values of the costructive dimensions of the smooth spreading working part, which evenly distribute mineral fertilizers, were selected. Laboratory and field were tests of equal distribution conducted and the results were recorded in tables.

Keywords: slope, plow, mineral fertilizer, combined plough, speed.

I. Introduction

The use of the sensitivity functions of agricultural plants gives the opportunity to program productivity, requirements for machines and technologies, and the means of application of solid mineral fertilizers in the agricultural system (Pyataev M.V. 2014). The technological process of supplying different types of solid mineral fertilizers with structural machines consists of several technological operations that determine its direction (Mitchell D.1975). In order to prepare the technological process of introduction of solid mineral fertilizers, it is necessary to know the methods of application of fertilizers, their physical and mechanical properties, and to have machine complexes that ensure the fulfillment of agrotechnical and ecological requirements during cultivation (OST. 70.71 - 2000). Machines with a centrifugal working body apply powder and granular fertilizers over a large variable working width (Simakin A. I. 1988, Sedashkin, A. et.al. 2013). The main drawback of these machines is the uneven distribution of fertilizers, especially when working on slopes. These traditional disadvantages of the work of machines with centrifugal working bodies are the main reason for the intensive search for other constructive solutions. Therefore, machines with centrifugal working bodies are improved both in our country and abroad mainly in order to improve the uniformity of sowing and increase productivity.One of the main agrotechnical indicators of the operation of mineral fertilizing machines is the provision of even distribution of mineral fertilizers in the field (Abbasov İ.D. 2011, Alakbarov J.Q. et.al. 2001).

Due to the soil climate in the republic, for a number of reasons, it is advisable to use additional sowing of fertilizers in excess of the basic norm. First of all, this allows to refuse the production and release of a large number of technical means (Merzlikin A.S., et.al. 1995). As already mentioned, it is necessary to accurately determine the fertilizer rate for the planting stock of fertilizer plants.Compliance with this condition also requires the high quality of fertilizers: nutrients, humidity, granulometric result and the strength of granules, which affects more distribution of sowing on the field (Alakbarov F. 2016).

This is due to the fact that, for the first time, machines equipped with working bodies of the disc spreader type are larger than the design width of the working width of the machine itself (Sendryakov I.F., et. al. 1976., Klyatis L.M., et.al., 1979). Therefore, it is necessary to mark the field or equip the machines with markers to ensure the desired working width. It causes environmental pollution. The inhomogeneity of the field of nutrients created during fertilization is the main reason for the unevenness of many crops(Mitchell D. 1974, Nasonov V.A. 1984). Cereal plants also cause yield loss, some plants can reach 25-60%. According to the literature, depending on the structural characteristics of the sown and the quality of the fertilizers sown, the applied fertilizer can be unevenly distributed between

Author: "Agromechanika" Scientific Research Institute Aziz Aliyev 93, AZ2000, Ganja city, Azerbaijan. e-mail: genclik79@mail.ru

40-60% of the norm, which leads to nutrient deficiency. (Adamchuk B.V. et.al. 2004,Ostanin A. I., et.al.,1971)

An increase in the distribution rate of uneven strength fertilizers to 70-80%, a decrease in the yield of cereals by 11-15 s/ha was observed. The researchers of foreign scientists can also find that the yield in the areas paid for by fertilizers, the applied application of uneven fertilizers, the yield is on average 15% higher. Therefore, it is advisable to study the impact of local and foreign materials and the quality of fertilizer payment on the entire field, and the application of uneven fertilization machines of the field is created (Bagirov B. et. al. 2018).

II. Material and Methods

Research studies were conducted through literature, patent and internet searches, as well as advanced advanced research. When checking the newly developed combined plough, the established standards were used: (Afanasyev R.A., 2006)

1. General purpose boilers, methods of field tests - GOST-2911
2. Forestry and agricultural machines and tractors.Test admission rulesGOST 28305-89, (STSE 6546-88).
3. Test of K/T technique - Ost 70.4.2.-80
4. OST 70.2.16-72 in the evaluation of the main operational-technological inspections

The main indicators of the goal determined in the process of farm trials are:

1. Ensuring the equality of distribution of fertilizers on the working area,%;
2. Ensuring the equality of distribution of the fertilizer application rate along the length of the machine passage,%.

The purpose of the technological process and the evaluation of the quality indicator include the following:

1. Deviation of the actual application norm from the set norm;
2. Determining the unevenness of the application;
3. Determining the unevenness of the fertilizers along and across the field;
4. Determination of the working speed of the machine for uniform spreading of fertilizers;
5. Determining the productivity of the machine for uniform spreading of fertilizers.

Fertilizer application rate (Q) in kilograms per hectare is calculated by the following formula: (Adamchuk V., 2003)

$$Q = \frac{10\, q}{LB}\; ; \qquad (3.7.1)$$

Here:

q - the mass of fertilizers sown during the repetition of the experiment, gr;

L - length of the calculation area, m;

B – the width of the combined plough, m

The accuracy of the actual fertilizer application rate from the normalized determination as a percentage of the application working width (ΔQ) is checked by the following formulas:

$$\Delta Q = \frac{Q_y - Q_f}{Q_f}\; 10^{\,2}; \qquad (3.7.2)$$

$$Q = Q_{y1} \frac{V_y\, B_y\; \gamma_y}{V_f\, B_f\; \gamma_f}\; ; \qquad (3.7.3)$$

Here:

Q_y - is the norm of fertilizer application, the actual worker of the application reduces the best, kg / ha^{-1};

Q_f - the actual rate of fertilizers in the working width of the application at the beginning of the application period, kg / ha^{-1};

Q_{y1} – set fertilizer rate, kg/ha;.

The testing program of the solid mineral fertilizer dispensing machine includes:

1. Technical expertise;
2. Evaluation of the purpose and technical characteristics of the car;
3. To evaluate the performance of the process;
4. Assessment of the quality of the technological process.

III. Results

The structural model shown in Fig. 1. can be used to estimate the cost impact of uneven fertilization. However, research conducted in the republic and abroad has determined that the application of fertilizers in the scattering of modern machines causes not only fertilizer loss, but also environmental pollution. The actual anthropogenic characteristics of the soil in the fields depend on the uneven application of fertilizers by machines with spreading working bodies, which often varies up to 40 ... 60% in farm conditions. At the same time, the use of high rates of fertilizers leads to an increase in the risks associated with a decrease in productivity as a result of low-quality fertilization.

The high static strength of granular fertilizers at least 2.0 MPa ensures preservation of the granulometric content of fertilizers during application of fertilizers with modern machines.
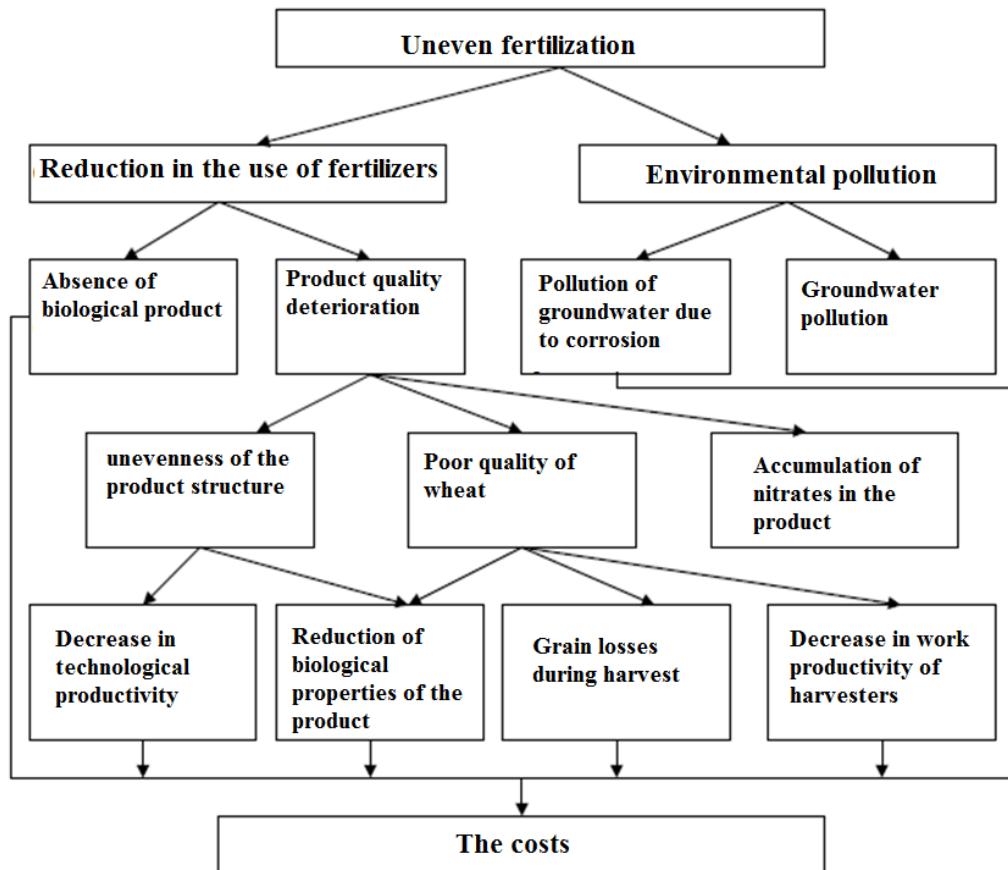
Fig. 1: Structural Model of Uneven Fertilization Management

According to the modern strategy, all decisions related to soil-plant impact are based on the average parameters of the cultivated area. If the illegality of the application exceeds the agrotechnical requirements, the content will be as follows(Pyataev M.V.,2010):

1. Exponential increase in the price of irreplaceable energy;
2. Increase in environmental pollution;
3. High variability of productivity and product quality.

All the above-mentioned indicators of the properties of fertilizers and technologies of application of fertilizers in the cultivation of plants were obtained while developing the agrotechnical requirements of new fertilizer spreading machines.

As can be seen in the picture Fig. 2, two ATP-2 fertilizer spreaders were installed on the plough. Movement of the devices is provided by the support wheel of the plough. The rate of fertilizer application is regulated by the change of stars. The scheme of technological process of the combined plough is shown in Fig. 2. The combined plough consists of two ATP-2 fertilizer spreaders (3) mounted on a Turkish-made SP-12 4-body plough (1). Fertilizers (3) receive movement from the plough support wheel (7) by means of chain transmissions (2). The support wheel is equipped with

rebar to prevent slipping. Fertilizers, moving from the support wheel, spread the fertilizer under the plow through four fertilizer pipes (5). A smooth spreader (8) is attached to the outlet of the pipes to ensure even distribution of fertilizers. The use of a combined plough before plowing completely reduces the operation of fertilizer application by fertilizer machines, its cost and labor costs, while ensuring high efficiency of fertilizer use, ie the submission of fertilizer to the ground prevents its loss, ensures even distribution, etc. In addition, it saves a lot of time and allows you to perform operations in a short time (Qurbanov H.N., 2023).
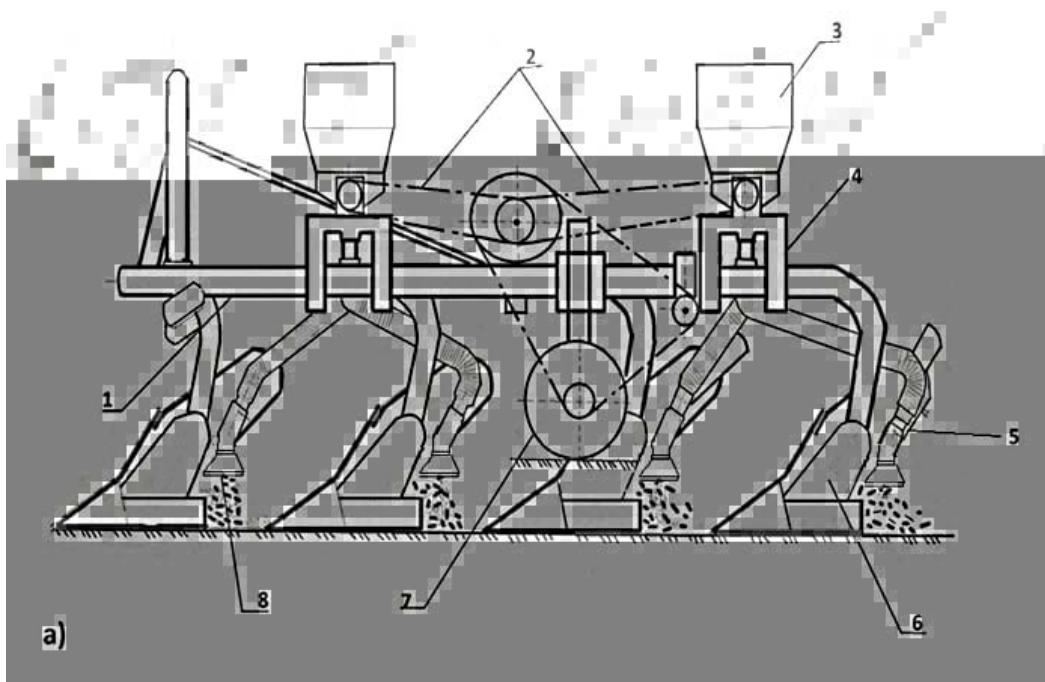
Fig. 2: Combined Plough. (a) Side View

1- plough frame, 2-chain transmission, 3-fertilizer, 4-fertilizer connecting frame to plough, 5-fertilizer transfer pipe, 6-plough body 7-moving support wheel, 8-smooth spreader,
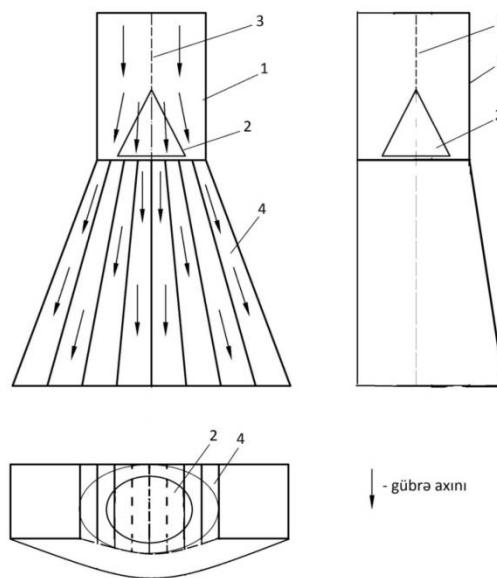
Fig. 3: Smooth Scatterer

1 - main face, 2 - cone with pendulum, 3 - chain, 4 - partitions

The experimental studies of the laboratory products of the technological process of sowing of solid mineral fertilizers show that the technological process of the fertilizer sowing norm is observed during the removal of granular fertilizer with a physical weight of more than 300 kg/ha. In addition, in addition, uneven distribution of fertilizer parts falling from the flow pipe in the soil is observed, which is around 40%. Experimental studies were carried out in the laboratory on the basis of a suitable device for 4 angle slope checks of the newly made smooth scattering part(Qurbanov H.N., 2022).
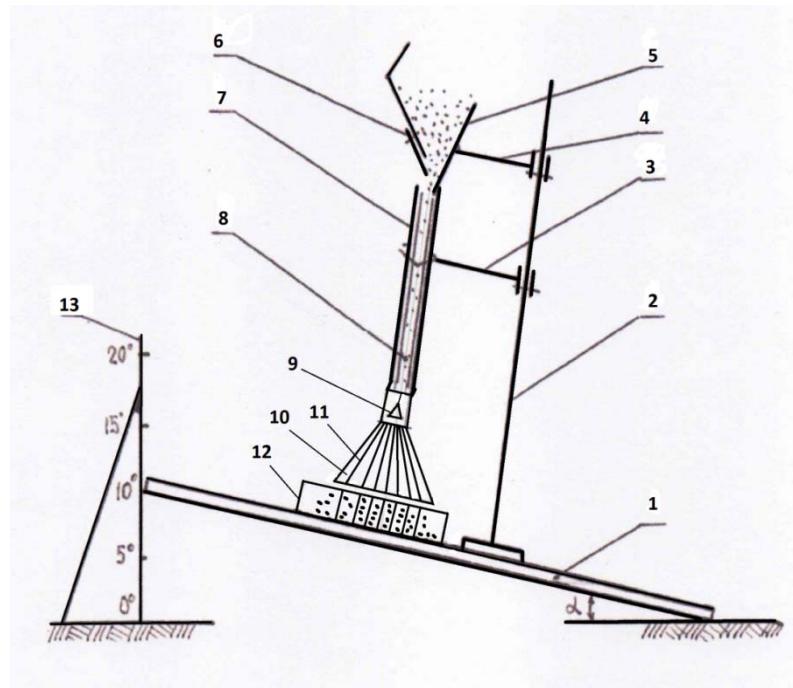
Fig. 4: Device for Determining the Scattering Equation of a Smooth Disperser

1- main support; 2- tripod; 3; 4 - holder; 5 - fertilizer box; 6 - valve regulating the fertilizer rate; 7 - cover of the fertilizer pipe; 8 - fertilizer pipe; 9 - pendulum cone; 10 - fertilizer distributor; 11 - partition; 12 - partition container for pouring fertilizer;13 - regulating the inclination along the vertical support

In the laboratory, the main 3 types of fertilizers were selected (urea, double superphosphate, potassium chloride) and the spreading percentages of the poured fertilizer were additionally determined in 8 partitioned containers.

Fig. 5: Laboratory Tests

Conducting a field trial. A sloping site in the Goy-Gol area was chosen for the implementation of the experimental research.Before starting the research, 3 types of fertilizers were taken, moisture was measured with a KE-108 measuring device, 9% in urea; it was 8% in double superphosphate and 8% in potassium chloride.

Fig. 6: A Field Test

The inclination of the slope was measured with an "Eklimeter" brand device, with an inclination of 5°, 10°, 15°, and the research area was selected. Soil moisture was measured with a KE-108. device and was 18%

Fig. 7: The Device Measuring the Angle of Inclination of the "Eklimeter" Brand

By filling two hoppers with the capacity of the combined plough, the slope width speed and aggregate movement condition were detected, 4 tests and 5 repeated operations were performed. for three types of fertilizers

Fig. 8: Field Testing of the Combined Plough
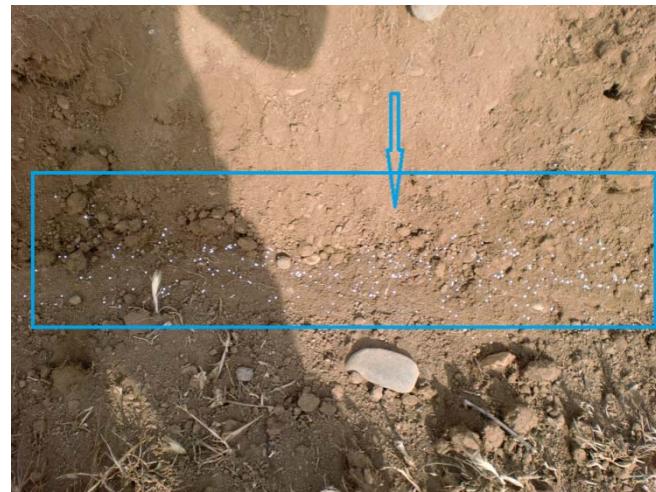
Şəkil 9: The State of Application of Urea Fertilizer to the Soil

IV. Discussion

Reliability of distribution according to the technological scheme can be achieved under the condition that the selection of structural dimensions of the smooth spreading part allows optimal fertilizer distribution (Serzhanov I. M. 2013).

Optimization of the main structural parameters of the smooth scattering working body. The dimension parameters of the pendulum cone, which is the working body of the smooth scatterer, are taken as the basis of the cone (tg γ) angle, cone height (h), cone diameter (d), distance between the cone and the wall (Z), and the charge distance from the cone to the partitions (h1) (Sivukhin D.V. 2005, Stromberg A. G., et. al. 2009). The main parameters of the subject on dispersion width (D) were calculated and are given in Table-1. Based on mathematical calculations, the parameters of the working subject were selected as dispersion width (D). According to the conditions of the one-factor experiment, the distance between the cone and the wall (Z) and the charge distance from the cone to the partitions (h1) were taken with fixed numerical values by obtaining mathematical dependencies.

Table 1: Optimizing Cone Size Parameters

№	distribution angle, tg γ	h, height, sm	d, diameter, sm	cone-to-wall clearance distance (Z), sm	h_1, distribution distance from the cone to the partitions, sm	D, spread width, sm
1.	20	3	2.18	1	25	20.38
2.	21	3	2.30	1	25	21.49
3.	22	3.5	2.83	1	25	23.03
4.	23	3.5	2.97	1	25	24.19
5.	24	4	3.56	1	25	25.82
6.	25	4	3.73	1	25	26.87
7.	26	4.5	4.39	1	25	28.77
8.	27	4.5	4.59	1	25	30.06
9.	28	5	5.32	1	25	31.90
10.	29	5	5.54	1	25	33.26
11.	30	5.5	6.35	1	25	35.20
12.	31	5.5	6.61	1	25	36.65
13.	32	6	7.49	1	25	38.74
14.	33	6	7.79	1	25	40.26
15.	34	6.5	8.77	1	25	42.49
16.	35	6.5	9.10	1	25	44.11
17.	36	7	10.17	1	25	46.50
18.	37	7	10.55	1	25	48.23
19.	38	7.5	11.72	1	25	50.78
20.	39	7.5	12.15	1	25	52.64
21.	40	8	13.44	1	25	55.38
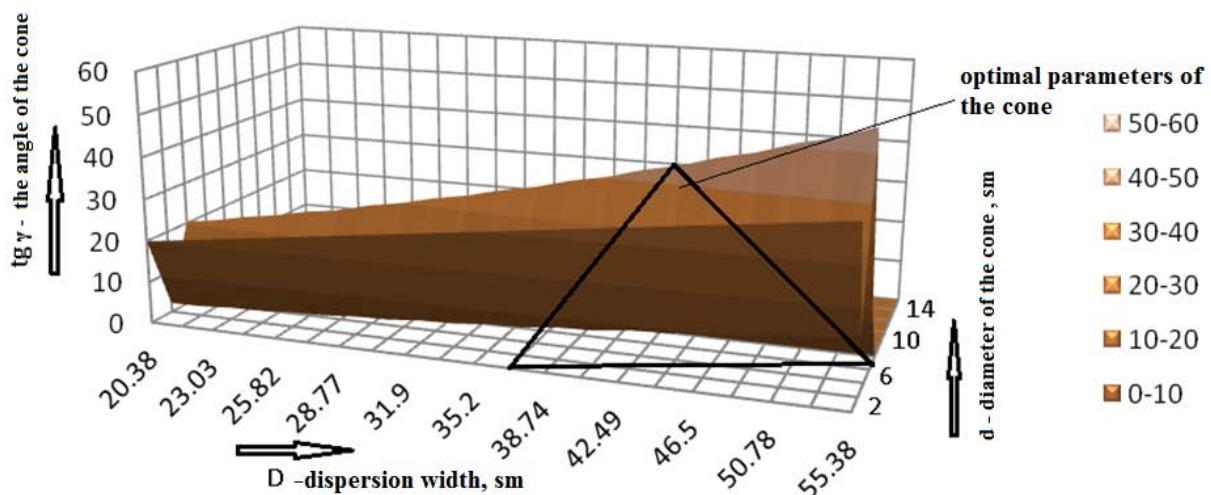
Fig. 10: Optimization Graph of Cone Parameters

Due to the fact that the working width of the cranberry in the plough trunk is 35 cm, the required spreading width D=35.2 cm, the angle of the cone tg γ =30 degrees, cone height h = 5.5 cm, and cone diameter d = 6.35 cm are taken from Table 4.8. The clearance distance between the cone and the wall Z =1 cm and the charge distance from the cone h_1 = 25 cm are taken as fixed values.

In order to verify the reliability of the control studies, to improve the proposed design of the machine and to justify its operating modes, field studies are determined, which ensures the spreading of fertilizers in the field.

Table 2: Technical Parameters of the Combined Plough

Indicator	Numerical indicator
Productivity, ha/hour	0.7...0.9
Working width, m	1,4
Number of working bodies, PCS	4
Weight, kg	700
Overall dimensions, mm	
Length	3120
Width	1700
Height	1300
Working depth, cm	20...22
Working speed, km/h	3.9...6
One working width, mm	350
Number of bunkers, PCS	2
Bunker capacity, dm^3	45
Norm of mineral fertilizer applied per 1 ha, kg	65...328
Type of attachment to the tractor	hanging
Aggregates with 30 kN class tractors	1

Table 3: Indicators of Even Distributon of Fertilizer in the Inclined Conditions of the Speader

Name of Indicators	Inclinationangle			
	0°	5°	10°	15°
Ureafertilizer				
Equaldistribution, %	96.08	94.65	92.17	88.81
In the 1st period of the fertilizer shaft, gram	82.57	81.32	79.22	76.32
Doublesuperphosphatefertilizer				
Equaldistribution, %	97.63	96.85	94.34	92.82
In the 1st period of the fertilizer shaft, gram	129.26	128.23	124.91	122.89
Potassiumchloridefertilizer				
Equaldistribution, %	96.95	96.62	94.72	93.72
In the 1st period of the fertilizer shaft, gram	118.74	118.34	116.02	114.79

When the fertilizers were spread evenly in the laboratory, urea was 92.37%, double superphosphate was 94.96%, and potassium chloride was 95.42%.

Table 4: Equal Spreading of Fertilizers in the Sloping Conditions of the Slope

Indicators	Slope			
	0°	5°	10°	15°
	AMAZONE ZA M -1500			
Amount of fertilizer thrown from the left disc, kg	12.3	13.93	15	19.93
Amount of fertilizer thrown from the right disc, kg	12.3	11.86	10.33	9.33
Equal distribution, %	100	85.14	68.87	46.81
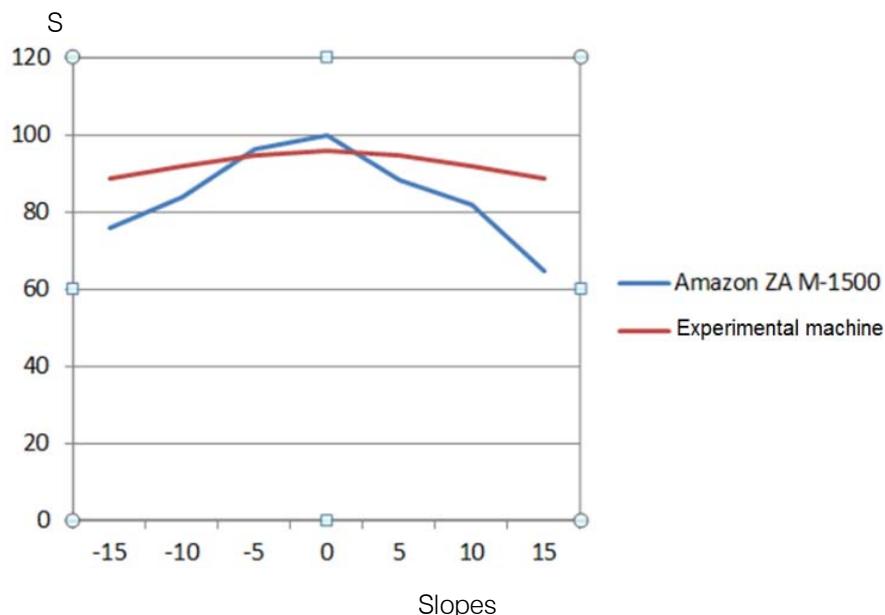
Fig. 11: Distribution Graph of Mineral Fertilizers in the Soil with the Amazone ZA M-1500 Machine and the Experimental Machine

The results of the research work, the table IV and the fig.11 clearly show that the Amazon ZA M-1500 machine distributes fertilizers unevenly in the field.
The regression equation is obtained for a smooth uniform scattering (Melnikov S.V., 1980).

For urea fertilizer

$$Y = 93.9 - 0.75 X_1 - 1.59 X_2 + 0.1 X_1X_2$$

For double superphosphate fertilizer

$$Y = 95.04 - 0.57 X_1 - 1.84 X_2 - 0.18 X_1X_2$$

For potassium chloride fertilizer

$$Y = 95.50 - 0.33 X_1 - 1.28 X_2 - 0.17 X_1X_2$$

S_{sep}, %
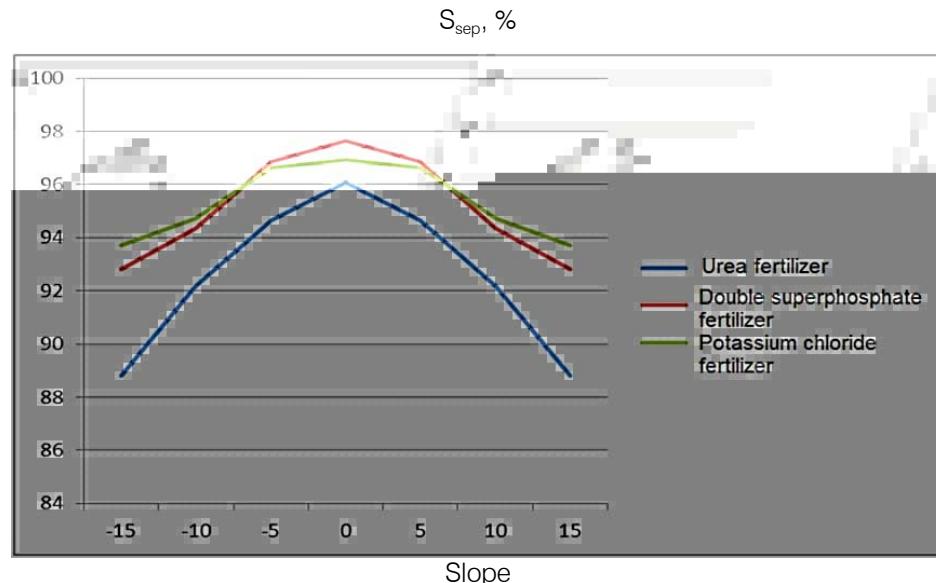
Fig. 12: Percentage of Even Distribution of Fertilizer on Slopes

Experiment planning plays a key role in the efficient and speeding up of research work.

The planning of the experiment is to experiment on the factors that seriously affect the function by reducing the number of factors without taking into account the low values of the factors that affect the function by identifying multifactor dependencies.For this purpose, the regression equation of the multi-factor function of scattering productivity is drawn up using the grapho-analytical method.

The general expression of the regression equation

$$\sum W_{s\partial p} = 20.38 v + 4.34 Q + 47.65 \frac{1}{B} + ... + ...;$$

$$\sum W_{s\partial p} = 20.38 v + 4.34 Q + 47.65 \frac{1}{B} + 20.38 * 4.34 v Q + 20.38 v^2 + 4.34 Q^2$$

8 partitions
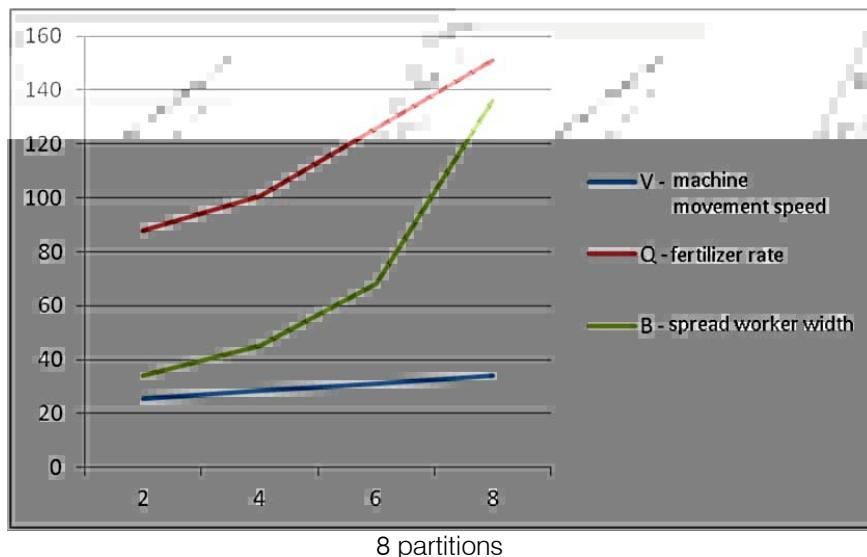
Fig. 13: The Main Factors that Affect the Productivity of Scattering

From the graph in Fig. 13, it is clear that Wsep - the 1st factor that most affects the sowing productivity Q - fertilizer rate, 2nd factor B- spread worker width,3- the less influential factor V is the speed of movement of the machine.

Table 5: Economic Comparison Table

s/s	The name of indicators	Unit of measurement	Mechanization options			
			SP -12 plough	Amazone ZA M -1500	Single time operations Total	Experimental Combined plough
1.	Productivity	ha/h	0.72	5.12	0.72	0.72
2.	Duration of technological operation	h	450	450	450	450
3.	Capital investment	dollars	8.17	20.05	28.22	14.88
4.	Depreciation expense	dollars	398.22	3.4	401.62	399.18
5.	Current repair and maintenance costs	dollars/ha	16.40	6.48	22.88	17.89
6.	Fuel and lubricant costs	dollars/ha	12.23	1.72	13.95	12.23
7.	Operating costs	dollars	1346.9	931.91	2278.80	1348.74
8.	Costs incurred	dollars	1348.94	936.92	2285.86	1352.45
9	Economic efficiency	dollars	-	-	-	933.40
10.	Economic efficiency in grain growing	ha/dollars	-	-	-	123.53
		kg/ha	-	-	-	600
11.	Economic efficiency during the growing season in grain growing	dollars	-	-	-	40023.53
		t	-	-	-	194.4
12.	Overall economic benefit	dollars	-	-	-	40956.93

Table 5 shows a comparative analysis of technological operations (Merzlikin A. S., et. al. 1999). Thus, the smooth and even distribution of mineral fertilizers in the field with the use of combined plough increases the productivity in grain growing from a minimum of 26 s/ha to 32 s/ha. If we calculate that a kilogram of wheat costs about 21 cents, 600 kg per hectare allows us to get an economic benefit of 123.5 dollars/ha, and during the season - 3200 hectares of land with an economic benefit of 40 003 dollars.

V. Conclusion

1. Plowing and fertilizing work on the slopes was performed in one go by using the combined plough. Fertilizing evenly under the soil prevents environmental pollution and increases the efficiency of fertilizer use.
2. As a result of economic testing of the combined plough, the working speed was 3.9 ... 6 km/h, the working width was 1.51 m, the cultivation depth was 20... 25 cm, the fertilizer application rate was 65 ... 328 kg/ha.
3. Uniform distribution of urea fertilizer under the soil was 92.0%, double superphosphate - 94.0%, potassium chloride - 93.0%.
4. Field and farm experiments have shown that with the reduction of uneven dispersion of mineral fertilizers with experimentally combined plough provides 20% of minimum green mass productivity and grain growth of 600 kg/ha.
5. As a result of the application of the combined plough, labor costs are reduced by 14.65% and operating costs by 18.3% compared to the usual method.
6. The annual economic benefit of one device is US $933.4 due to the difference in costs incurred.

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Modelling the Plant Silicon Hydraulic Capacitance and Passive Uptake under Drought and Saline Conditions

By El-Shazly Mohamed Hegazy

Cairo University

Abstract- Silicon is the second abundant element in the earth's crust and may also exist in sufficient amounts in groundwater. The sprinkler irrigation with groundwater increases the silicic acid in soil water and therefore silicon uptake by plant root especially under abiotic stress conditions. As the silicon uptake process is mainly passive with mass flow, the soil water hydraulic capacitance was modified to express the process of silicon passive uptake because each soil skeleton has its unique concentration of silica due to its mineralogical decomposition. Silicon like hydraulic capacitance, B_Si represents the fast reservoir of the soluble form of silica ready for root uptake and translocation to do its best for combating the adverse impacts of global climatic changes on the agro ecosystem's continuum such as water and nutrients deficits, salinity stress, heat sock, and diseases. AMUN_SiHC model which is created to calculate the soil water hydraulic capacitance, siliconlike hydraulic capacitance, water and silicon passive uptake, was derived, run, and discussed.

Keywords: silicon passive uptake, silicon hydraulic capacitance, drought, salinity.

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Keywords: silicon passive uptake, silicon hydraulic capacitance, drought, salinity.

I. Introduction

The soil water hydraulic capacitance, β, a tank like the plant water reservoir, is being controlled by signals, valves like the switches. There are three types of signaling devices control the mass flow of water and nutrients, Geo, Bio, and weather controlled. The Darcian flow of water carries with it nutrients toward root in accordance with their concentration. The property of soil hydraulic capacitance determines the type of root water and nutrient uptake under drought and saline conditions in accordance with stress, strain, and weather-controlled forces. It was first discovered by the author when modeling the wheat root water uptake under drought and saline stress conditions [1]. The latter signaling devices not only control soil water hydraulic capacitance and uptake but also silicon passive uptake in such a way to make it equal the product of multiplying soil stress index with a modified value of soil water hydraulic capacitance, silicon like (β_Si).

Treating plants with silica products was the common managerial practice used for enhancing uptake and plantation under the extreme drought and saline conditions. Soil moisture reservoir represents the plant available water affects the recharge of aquifers capacitors. It is also a vital source of upward atmospheric humidity and accordingly, the downward precipitation. The soil moisture reservoir represents the plant available water affects the recharge of aquifers capacitors. It is also a vital source of upward atmospheric humidity and accordingly, the downward precipitation. Soil moisture contributes to regulating the global energy balance of terrestrial ecosystems, controlling soil temperature, air humidity, and surface albedo [2]. Moisture deficit causes drought attack. By the year 2030, the global climate change will be changing the half of the world's population to be lived in areas of water scarcity. In some arid and semi-arid regions, it will displace up to 24: 700 million people due to water stress problem [3].United Nations (2010) chose the decade 2010–2020 for the fight against desertification. This is because the following reasons: 41.3% of the earth surfaces are drylands, approximately 44% of all the world's cultivated area located in the dry lands. The desertification, land degradation may cause severe dust storms, which can lead to respiratory diseases and other health problems [4]. Drought threats more than 1 billion people from the 2.1 billion people who live in the dry regions and responsible for an income loss of US$ 42 billion per year. In the most dried year, the cropping season 2009/2010, most of the world cropland faced severe drought waves which affected the crop productivity.

Soil salinization can be enhanced by the climatic changes, rising temperatures, increase soil evaporation, and crop water requirements. The coastal regions are vulnerable to see water intrusion, thereby deteriorating the coastal aquifers. The extreme storms and tsunamis waves can flow overland resulting in saltwater infiltration into soils contaminating soil and water resources [5].The problems of arid zones and their accompying results, salinization and desertification, are highlighten end in the countries where no renewable water resources exist such as Saudia Arabia [6]and Kwait [7].

Author: Natural Resources Department, Faculty of African Postgraduate Studies, Cairo University, Giza, Egypt.
e-mail: shazlygazouly@yahoo.com

Robinson, D.et al. [2] defined soil hydraulic function as the ability of soils to store water to serve the moisture pool that sustains the agro ecosystem system. They said that soil hydraulic functions are always estimated as static property, such as relating to hydraulic conductivity and soil water retention. They neglect the interaction between the agro-ecosysrem components which do their best either alone or in combination reducing the moisture deficit signal. The soil living organisms could change soil structural and accordingly the moisture deficit. As soil available water decreases due to drought and salinity stress conditions, the agro-ecosystem components, plant and soil, start to do on their relative extreme response functions. The relative extremes may be achieved by root through choosing the easiest bath to navigate soil system, categorizing the energy states of soil water, preferring the easiest available water to water, and following model of minimizing the consumed energy for combating stress conditions. The interaction between ecosystem components, plant and soil; due to drought cycles, the soil is shrinking its energy now to the half of its value at the wetting cycles to save plant's life and prevent the hydrological release. By limiting crown roots number per plant, plant causes a degree of response towards the drought stress, a compensatory growth in existing roots, which subsequently reaches deeper soil layers, categorizing the energy states of soil water seeking the easiest available water and nutrient for compensation. In tillering crops such as wheat, a drying soil was found to limit root growth at the top 30 cm using the hydraulic signal for increasing cell wall elastic modulus and maintaining turgidity while promoting root extension and growth into depth.

Estimating the root water uptake when using the stress form of modified Richard's equation, S= SSI*B, involves the term soil water hydraulic capacitance. SWHC represents the response of the soil moisture reservoir toward a certain plant water demand under a certain atmospheric condition. Soil profile consists of layered capacitors. Each of which is recharged during the precipitation, irrigation, capillarity, or water table rise forming the constant shaped soil moisture profile after moisture redistribution. The easy available water is being stressed by discharging the soil capacitors during the root water uptake creating the variably saturated zone. In between the sink/source terms of Richard's equation, the discharge/ recharge terms of soil capacitors or the root uptake, hydrological release terms, root navigates soil capacitors categorizing their energy states to select what has the easiest available water and bath to pass and water by exerting a minimum consumed energy. SHC depends on soil genesis, plant species, varieties, ages, adaptability, atmospheric conditions, and the high tensile strength of liquid phase. Under deficit irrigation and or the harsh extreme conditions of aridsols, SHC determines the types of water uptake in accordance with weathering induced stress- strain signaling devices [8]. The latter devices are being regulated for the sake of preventing the hydrological release and complete the life cycle.

It had been the big bang separated planet earth from star sun. The separated mass had cooled and the basic element had cocked in a hydrothermal environment to form minerals [9] (Figure 1)..Silicon and aluminum bonded with oxygen forming silica tetrahedron and alumina octahedron, the basic units of clay minerals with their distinguishable isomorphs substitution [10].
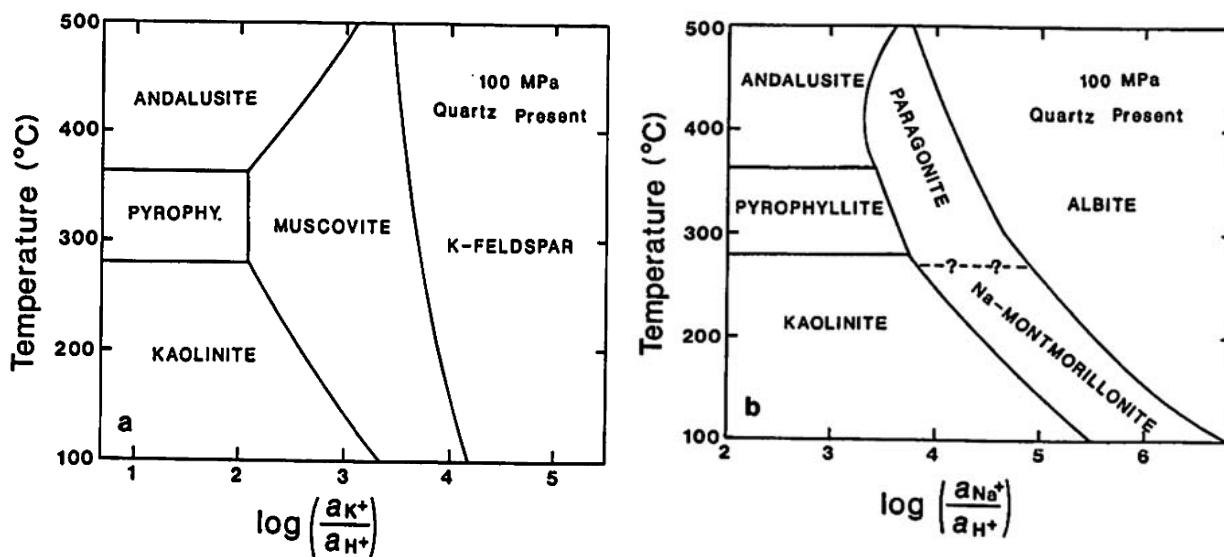
Figure (1): A: Temperature- Logarithmic Cation Activity Ratio Diagram in the System K_2O- AL_2O_3- SiO_2- H_2O at a Total Pressure of 100 MPa and Quartz Saturation. B:Temperature- Logarithmic Cation Activity Ratio Diagram in the System Na_2O- AL_2O_3- SiO_2- H_2O at a total Pressure of 100 MPa and Quartz Saturation [11]

The merciful behavior between silicon as a basic soil skeleton constituent and mankind as a clayey apped creature, under harsh extreme stress conditions, may be summarized as dust support dust in order to let the life continue [1]. Silicon the second abundant element in earth's crust, the beneficial functional nutrient element for human, animal, and plant is from the types of environmental managerial practices should have been taken into consideration when dealing with the natural abiotic stress of drought and salinity due to global climatic changes or artificial one due to irrigation deficit scenario because of the three incoming reasons:

1. Since the geo-signal is being induced by more compacted electric double layer, hysteric behavior and the Albert Ainkhtien's relativity of clayey lattice [8].
2. As the bio signal is being induced by osmoregulation strain and turgidity strain[1].
3. As the weather controlled signaling device is being induced by canopy evaporative demand [1].

Silicon enhances the overall signaling devices to be in favorable states under the abiotic stress conditions. It deposites in tricombs enhancing its function in cooling leaves acting as antenna reflects the solar short incoming radiation.. Treating the sulfuric acid aerosols in the stratosphere with silica aerosols reduces significantly the short incoming radiation. Accordingly, increases the Mie scattering in the stratosphere. Accordingly, reducing the impact of global temperature rise by cooling the at mosphere in general and plant canopy in particular. However, the silicon are rosols is an effective managerial practices for albedo modification, particular technology should be adopted control the silicon radioactivity.

Silicon deposits in root enhancing the plant roots to be in a higher negative potential state for overcoming the total potential of soil water. The siliceous nutrition of plants is not only scientifically intriguing but also important in a world where more food will have to be wrung from a finite area of land especially for the deficit irrigation and partial root zone drying scenarios which will put crops under stress. [12and 14].

In the agro-lands of MENA countries with marine and lacustrine origins, the overexploitation of groundwater under the conditions of water scarcity and global climatic changes causes the intrusion of seawater [5]. As the saline water intrudes the variably saturated zone under a harsh extreme condition, the potentially guided Darian flow charges the capacitors from the bottom upwardly. Charging the capacitors in the electrical model [15] is different than that of the AMUN_SHC electrical model [1] as the former did not consider that water quality affects its uptake. For instance, the water salinity decreases the availability of irrigation water. AMUN_SHC model takes the concept of total energy states into consideration. Assessing the impact of specific ion toxicity has a certain value of salt index under abiotic stress conditions may be achieved by making SSI speciation. The latter speciation may be done in order to know the combined stress of drought, salinity and specific ion effects such as in the case of using potassium chloride instead of potassium sulfate fertilizers. SSI speciation, SSIS, is still under investigation. Moreover, SSIS needs to be validated when assessing the impact of saline contaminated groundwater with iron and manganese on plant growth under deficit irrigation scenarios.

The plant response under environmental abiotic stressed conditions could be discussed from the side of dynamics in plant roots and shoots used to minimize stress, reduce consumed energy, and maintain water and nutrient uptake [16 and17]. Firstly, plant enhances the uptake of nutrient element responsible for combating abiotic stress, silicon. Secondly, the beneficial functional element, silicon, interact positively with macro and micronutrient and stimulate the biophysical functions inside plant's tissues [12]. Thirdly, Silicon also appears to be a part of the osmoregulation within cells subjected to drought stress which enables the plant to uptake and transpire more water for combating the stressed conditions [18]. Fourthly, the wheat's hydraulic signal reduces water loss via transpiration by decreasing leaf area index and increasing leaves rolling [19]. Fifthly, the adaptive root growth [20], the compensated root water uptake [21], and root hydraulic redistribution to cope with the heterogeneity in soil moisture regime [22]. Under such conditions,, It makes sense to butsilicon uptake in one side andother nutrients and water uptake in the other in order to complete the plant life and prevent the hydrological release.

The object of this research is to quantify the Darcian silicon uptake by changing the water uptake response function, $S = (\beta, SSI)$, to be the silicon Darcian uptake response function, $Si\_Up = (\beta\_Si, SSI)$.Silicon, the master element under such stress conditions, may be correlated with other nutrients and water uptake.

II. MATERIAL AND METHOD

Whey is the foliar application of silicate fertilizers or sprinkler fertigation of silicate ions recommended under stress conditions?

The following points will clarify the reasons and limit the debates:

1. The fast supplying reservoir of the soluble form of silica ready for plant root uptake and translocation to do its best for combating the adverse impacts of global climatic changes provided 40.79, 55.9, and 54.58 ppm in the experimental plot 1, 2, and 3 respectively (Table 1).

2. Silicon which forms inner and outer sphere complexation may be desorbed to support plant growth under stress conditions.
3. Ground application silicate fertilizers may refresh the soluble quick equilibrium between the up taken form and the soluble available form of silicates.
4. As silicon is the second abundant element in the earth's crust, the slowly dissociation of silicate minerals replenishes and compensates the depletion of the absorbed silicic acid in the rizosphere by silicon accumulator crops such as sugarcane and wheat.
5. As silicon is mainly absorbed by mass flow of water, the factors affecting soil water hydraulic capacitance

and uptake may affect the silicon hydraulic capacitance and therefore, the passive silicon uptake. Accordingly, the highly energetic soil water due to drought and salinity, reduces water uptake and soil silicon passive uptake.
6. The foliar application of silicate fertilizers is recommended than ground one in the case of the abiotic stresses of drought and salinity due to its abundance in soil skeleton, slow release from silicate minerals, but less available due to the high negative total soil potential may reduce the water and soil silicon uptake or even the hydrological releases under the harsh extreme abiotic stress conditions.

$$AL_2Si_2O_5 + 2H^+ + 3H_2O \longrightarrow 2AL^{3+} + 2H_4SIO_4 \quad \text{Log } K^0 = 15.12$$

$$AL_2Si_2O_5(OH)_4 + 6H^+ \longrightarrow 2AL_3^+ + 2H_4SIO_4 + H_2O \quad \text{Log } K^0 = 5.45$$

As drought and salinity reduce the silicon uptake from soil solution, they were managed by foliar spraying of silica products as potassium silicates and sodium silicates in three concentrations 0.0, 30.6, and 40.8 ppm. All of them were foliar sprayed at ages of 45, 60, and 75 days from seed emergence at the early morning. The 6 treatment combinations were distributed in 3 salinity levels, 3.12, 4.82, and 5.12 dS/m (Table 1), in a split-split plot design with four replicates. Soil hydro physical properties and water flow parameters were

estimated by HYDRUS- 1D (Vr. 4.17) at depth z dimension (Table 2). ET_C was calculated from meteological data [23]. The irrigation interval each 20: 25 day. The relation between soil stress index and plant stress index was developed [8]. The AMUN_SiHC was built and run to calculate silicon hydraulic capacitance, β_Si (Figure 2).All the read input parameter were taken, processed to output PSI, SSI, β, β_Si, and Si_Up, and by run the program [24].

AMUN_SHC Processing Code

- $SSI = \dfrac{(1+(\alpha\Psi)^n)^m}{(1+(\alpha\psi*)^n)^m} \qquad (m = 1/n)$

- $\beta = \left(\dfrac{1}{SSI(z,t)}\right)\left(\dfrac{\frac{1}{Z2-Z1}\left(k\frac{\Psi2-\Psi1}{z2-z1}-k\right)}{-c(h)\frac{\Psi2-\Psi1}{t2-t1}}\right)$

- $Bsi = c\left(\dfrac{1}{SSI(z,t)}\right)\left(\dfrac{\frac{1}{Z2-Z1}\left(k\frac{\Psi2-\Psi1}{z2-z1}-k\right)}{-c(h)\frac{\Psi2-\Psi1}{t2-t1}}\right)$

- $S(h,z,t) = \beta \cdot SSI(h,z,t) \qquad \beta = Tp.\dfrac{PSI}{SSI}$

- $S_{si}(h,z,t) = \beta si \cdot SSI(h,z,t) \qquad \beta_{si} = (Tp).c.\dfrac{PSI}{SSI}$

- $(PSI)_{j+1}^i = \left(\left(\dfrac{(SSI)_{j+1}^i}{-(SSI)_j^i}\right)\Big|(SSI)_{j+1}^i\right)\left(KC\left(\dfrac{\Sigma_{j=1}^{j=n}(PSI)}{n}\right)\right) + \left(\dfrac{\Sigma_{j=1}^{j=n}(PSI)}{n}\right)$

- **Compensated Silicon Uptake =**

$(c.\theta_V.\Delta z^2.h*/Tp)\left[\left(\dfrac{(PSI)_n^{SSI+\Delta SSI}}{-(PSI)_s^{SSI+\Delta SSI \square}}\right) + \left(\dfrac{-(PSI)_n^{SSI}}{(PSI)_s^{SSI \square}}\right)\right]\left[\left(\dfrac{(Tc)_n^{h+\Delta h}}{-(Tc)_s^{h+\Delta h \square}}\right) + \left(\dfrac{-(Tc)_n^h}{(Tc)_s^{h \square}}\right)\right]$

Figure 2: AMUN_SiHC Processing Code

Table 1: The Major Physical and Chemical Characteristics of the Soil and Irrigation Water of the Three Plots of the Experiment at Oraby Village, Maryout area Alexandria (2009/2010)

Characters	Plots and Irrigation Water			
	Plot 1	Plot 2	Plot 3	Irrigation Wt.
Sand (%)	17	23	15	
Silt(%)	37	38	38	
Clay (%)	46	39	47	
Texture	Clayey	Clayey L.	Clayey	
pH	8.35	8.4	8.31	7.6
ECe (mS/cm)	9.6	6.3	10.4	0.26
Sol. Si(ppm)	40.79	55.9	54.58	1.5
Sol. Na	6.8 (meq/l)	9.0 (meq/l)	6.37 (meq/l)	38.3 ppm
Sol. K	0.72 (meq/l)	0.89 (meq/l)	0.71	0.72 ppm

Table 2: Soil Hydro-Physical Properties According to HYDRUS 1D [25]

	Θ_s (v/v)	Θ_r (v/v)	Ks(cm/day)	α (1/cm)	n	m
Clayey Texture	0.38	0.068	4.8	0.008	1.09	0.083
Clayey Loam Texture	0.41	0.095	6.24	0.019	1.31	0.24

The earth nutritional alkaloids were determined as follow: K^+, Na^+, Mg^{+2}, and Ca^{+2} by the Atomic Absorption Spectrophotometer (Perkin Elmer 1100). Concentrations of K^+, Na^+, Mg^{+2}, and Ca^{+2} were calculated as percentage. Determination of silicon was performed based on the colorimetric determination of blue silicomolybdic acid procedure and measured using Perkin-Elmer Spectrophotometer at wavelength 820 nanometer and was calculated as percentage [26]. Nutrient uptake were calculated as kg per feddan. Regression analysis of nutrients uptake (Kg/Fed.) was performed according to Microsoft Excel 2010 (Table 3).SSI and available water content were calculated with depth and time respectively according to [8].

III. RESULTS AND DISCUSSION

Figure 3 indicated that silicon hydraulic capacitance (SiHC) and therefore passive silicon uptake (Si_Up) decreases. Whereas the slightly saline soils have SiHC much more than saline ones and so as in the case of irrigation water. Accordingly, seawater intrusion diminishes the SiHC with the exception for the case of special soil, water, and plant managerial practices such as leaching and drainage for soil, magnetism for water, and silicon foliar application and gene transfer for the plant which use to raise SHC, Si_HC, and Si_Up in some degree of extend. In halophytes, PSI is always greater than SSI. Accordingly, SiHC and all the related parameter will be exceeded, according to the Tp and the opposite is true in sensitive plants. As silicon concentrates straw sap, it makes the root sap more strained. Therefore silicon allowed plants to withstand abiotic stress by shaking down the limits of actual stress plant roots may bear from the log phase until disappear. SiHC in control treatment is higher than in silicon treatments. The latter means that SSI is greater than PSI. Moreover, a little pulse of environmental abiotic stress will cause a greater negative response on crop yield without silica fertilization. Potassium silicate is better than sodium silicate in the latter manner because the soil under investigation is rich in clay mineral fixes potassium between its layers, At tapulgite (Figure3). As SiHC reveals the overall interaction between the ecosystem components the managerial practices affect the plant, soil and atmosphere and their interaction each to other may affect it. Treating the plant and soil with silica affects SiHC (Figure3).It will be possible to correlate the other nutrients to silicon because: The skeletal element, silicon is mainly up taken passively by root system. Silicon is a key nutrient element under the studied abiotic stress conditions.
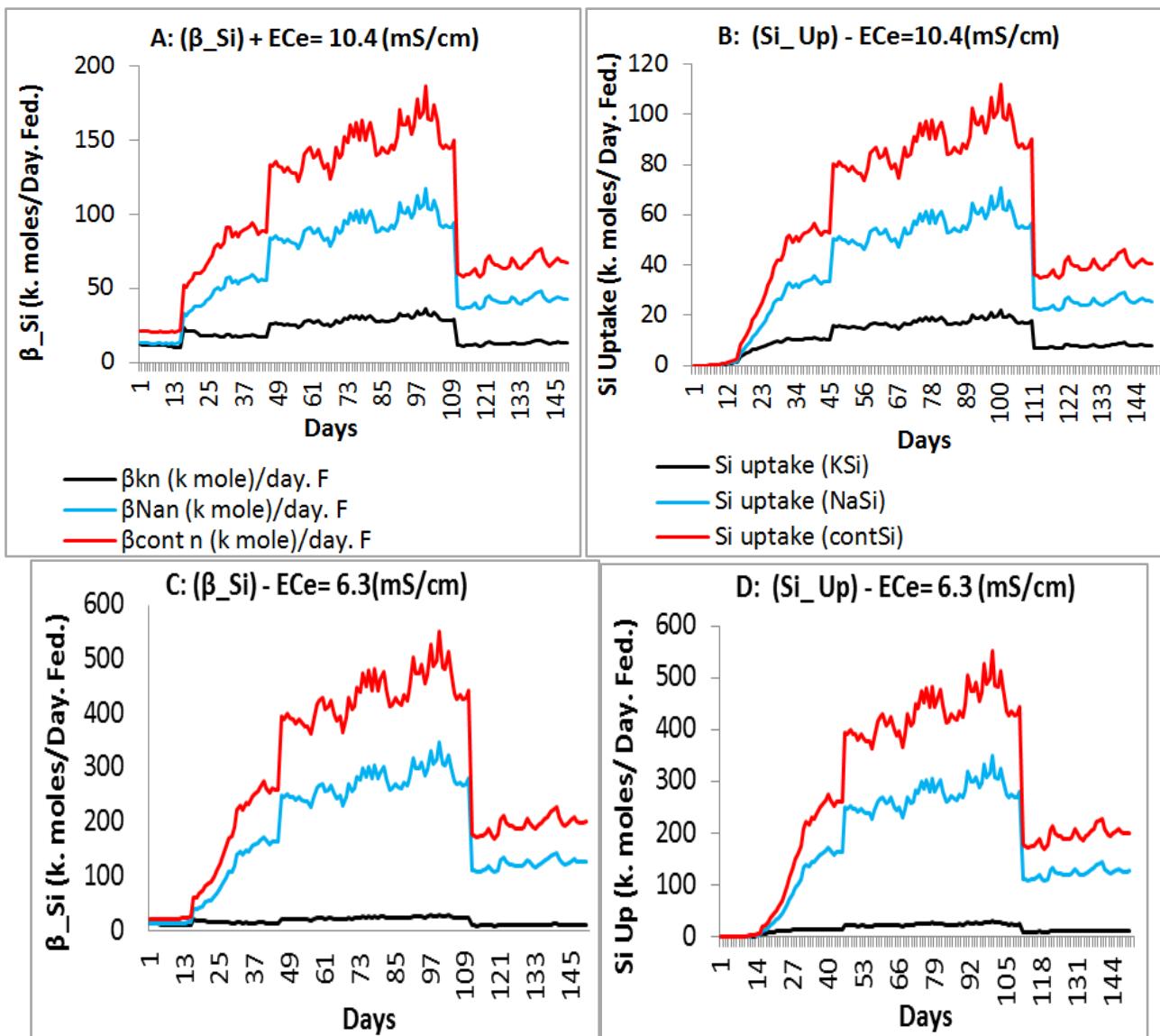
Figure 3: (A): Silicon Hydraulic Capacitance, (β_Si), for Saline Soil ECe= 10.4. (B): Silicon Passive Uptake, Si_ Up, for Saline Soil ECe= 10.4. (C): Silicon Hydraulic Capacitance, (β_Si), for Non-Saline Soil, ECe= 6.3.(D): Silicon Passive Uptake, Si_ Up, for Non-Saline Soil ECe= 6.3. The Unit of both β_Si and Si_Up is K. moles/ Day. Fed

Table 3: Regression Analysis of Some Nutrients Uptake Response Fuctions of Wheat Plant to Silicon Application Under Drought and Salinity Stress Conditions. Feddan= 1.05 acre

Dependent variable(y)	Potassium silicate(x)	Sodium silicate(x)
Magnesium uptake (kg/feddan)	$y = 7.3903\ln(x) + 6.4128$ $R^2 = 0.9999$	$y = 4.1105\ln(x) + 6.535$ $R^2 = 0.9807$
Calcium uptake (kg/feddan)	$y = 13.09\ln(x) + 9.6154$ $R^2 = 0.9947$	$y = -2.645x^2 + 13.425x - 0.94$ $R^2 = 1$
Sodium uptake(kg/feddan)	$y = -16.16\ln(x) + 37.352$ $R^2 = 0.9901$	$y = 10.1x^2 - 37.4x + 65.03$ $R^2 = 1$
Potassium uptake(kg/feddan)	$y = 12.428\ln(x) + 8.7508$ $R^2 = 0.9894$	$y = 5.2199\ln(x) + 8.9357$ $R^2 = 0.8635$
Silicon uptake(kg/feddan)	$y = 174.76\ln(x) + 140.03$ $R^2 = 1$	$y = 92.159\ln(x) + 139.22$ $R^2 = 0.9978$
K/Na uptake ratio	$y = 0.794\ln(x) + 0.2091$ $R^2 = 0.9966$	$y = -0.18x^2 + 0.77x - 0.37$ $R^2 = 1$

Three types of models are used for predicting the dynamics of geo-alkaloids towards the root system under stress conditions. They are as follows:

1. A multiple regression between soil salinity, drought, and available silicon in soil solution may control the water flow and geo-alkaloids dynamics towards plant root under abiotic stress conditions (Table 3).
2. The geo-alkaloids dynamics through variably saturated porous media are usually described using convection–dispersion equations [21].
3. AMUN_SiHC: Silicon, the skeletal second abundant element in earth's crust, absorbs passively with water flow and interacts +Ca, +Mg, +K, and –Na. Daily water uptake, daily soil water hydraulic capacitance, daily silicon uptake, daily silicon like hydraulic capacitance, daily potassium uptake, daily magnesium uptake, daily calcium uptake, and daily sodium uptake are the outputs

A further incoming research may compare between the experimental solution obtained from the latter multiple regression and the analytical ones.

AMUN_SiHC supports the applied research and development aiding manager to assess the impact of climatic changes to take the right decision

Some points of general significance in modelling plant water and nutrient uptake under drought and saline conditions using AMUN_SiHC They are as follow:

1. AMUN_SiHC supports the applied research and development aiding manager to assess the impact of climatic changes to take the right decision.
2. Allows methods for interpolation, extrapolation, and prediction.
3. Contains new valuable tools for environmental impact assessment which should be combined to show a unified valuable macrosopic picture for the soil system under stress conditions, SHC, SiHC, W_up, and Si_up. Accordingly, it provides new ideas and experimental approaches and allows the best use of data.
4. AMUN_SiHC provides a mathematical (Figure 2) and FORTRAN computer code for hypotheses to quantify the plant response to silicon foliar application under abiotic stress conditions.
5. Daily water uptake, daily soil water hydraulic capacitance, daily silicon uptake, daily silicon like hydraulic capacitance, daily potassium uptake, daily magnesium uptake, daily calcium uptake, and daily sodium uptake are the outputs of AMUN_SiHC. Accordingly, environmental modelling using AMUN_SiHC is in formative where precise fertigation is used. It allows pedologest to minimize the residual remaining fertilizers in soil after process fertigation. Therefore, it enables pedologest to phytocontain the fertilizers' nutritional elements in root zone using the concepts of soil water hydraulic capacitance and silicon like capacitance. The latters are the newborns of soil stress index model, SSIMOD (Figures 4 and 5).

$$S = \beta * SSI$$

$$\int_{(SSI)}^{(SSI+\Delta SSI)} S\ dSSI = \int_{(SSI)}^{(SSI+\Delta SSI)} \beta * SSI\ dSSI$$

$$\int_{(SSI)}^{(SSI+\Delta SSI)} S\ dSSI = 1/2 \int_{(SSI)}^{(SSI+\Delta SSI)} \beta\ d(SSI)^2$$

$$= 1/2[\ \beta * (SSI)^2 - \int_{(SSI)}^{(SSI+\Delta SSI)} (SSI)^2\ d\beta\ ]_{(SSI)}^{(SSI+\Delta SSI)}$$

$$= 1/2[\ \beta * (SSI)^2 + \alpha * Tp \int_{(SSI)}^{(SSI+\Delta SSI)} (SSI)^2 * (SSI)^{-2}\ dssi\ ]_{(SSI)}^{(SSI+\Delta SSI)}$$

$$= 1/2[\ \beta * (SSI)^2 + \alpha * Tp * SSI]_{(SSI)}^{(SSI+\Delta SSI)}$$

$$\therefore S\begin{pmatrix} SSI^{(SSI+\Delta SSI)} \\ SSI^{(SSI)} \end{pmatrix} = 1/2 \begin{pmatrix} \beta^{SSI+\Delta SSI}(SSI)^{2(SSI+\Delta SSI)} + \alpha 2Tp2 * (SSI)^{SSI+\Delta SSI} \\ -\beta^{SSI}(SSI)^{2\ (SSI)} - \alpha 1Tp1 * (SSI)^{(SSI)} \end{pmatrix}$$

$$\therefore S = \frac{\begin{pmatrix} \beta^{SSI+\Delta SSI}(SSI)^{2(SSI+\Delta SSI)} + \alpha 2Tp2 * (SSI)^{SSI+\Delta SSI} \\ -\beta^{SSI}(SSI)^{2\ (SSI)} - \alpha 1Tp1 * (SSI)^{(SSI)} \end{pmatrix}}{\begin{pmatrix} SSI^{(SSI+\Delta SSI)} \\ SSI^{(SSI)} \end{pmatrix}} \quad (Eq.\ 1)$$

$$\therefore S\_Si = \frac{\begin{pmatrix} \beta si^{SSI+\Delta SSI}(SSI)^{2(SSI+\Delta SSI)} + \alpha 2Tp2 * (SSI)^{SSI+\Delta SSI} \\ -\beta si^{SSI}(SSI)^{2\ (SSI)} - \alpha 1Tp1 * (SSI)^{(SSI)} \end{pmatrix}}{\begin{pmatrix} SSI^{(SSI+\Delta SSI)} \\ SSI^{(SSI)} \end{pmatrix}} \quad (Eq.2)$$

Where:

- SSI: Soil stress index
- β : Soil water hydraulic capacitance
- β_{si}: Silicon hydraulic capacitance
- $\Delta SSI = SSI2 - SSI1 = SSI^{(SSI+\Delta SSI)} - SSI^{(SSI)}$
- α_1, α_2, Tp_1, and Tp_2 are plant stress indices and potential transpiration constants for corresponding values of soil stress indices SSI_1, SSI_2
- S : water uptake due to ΔSSI
- S_Si: silicon uptake due to ΔSSI
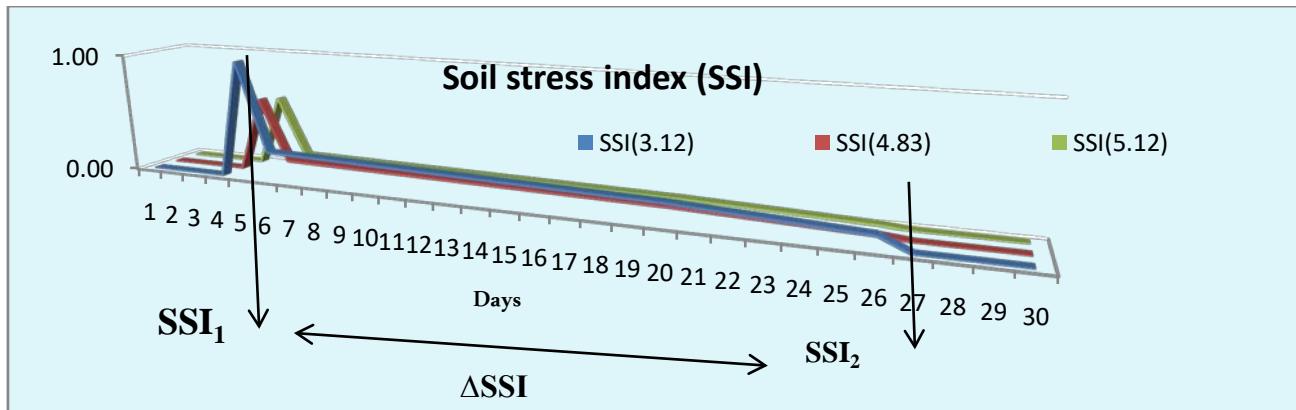
Figure 4.1: As Time is a Moisture and Accordingly a Soil Water Potential, ΔSSI Cauases Change in Water and Silicon Uptake (Eqs. 1 and 2)
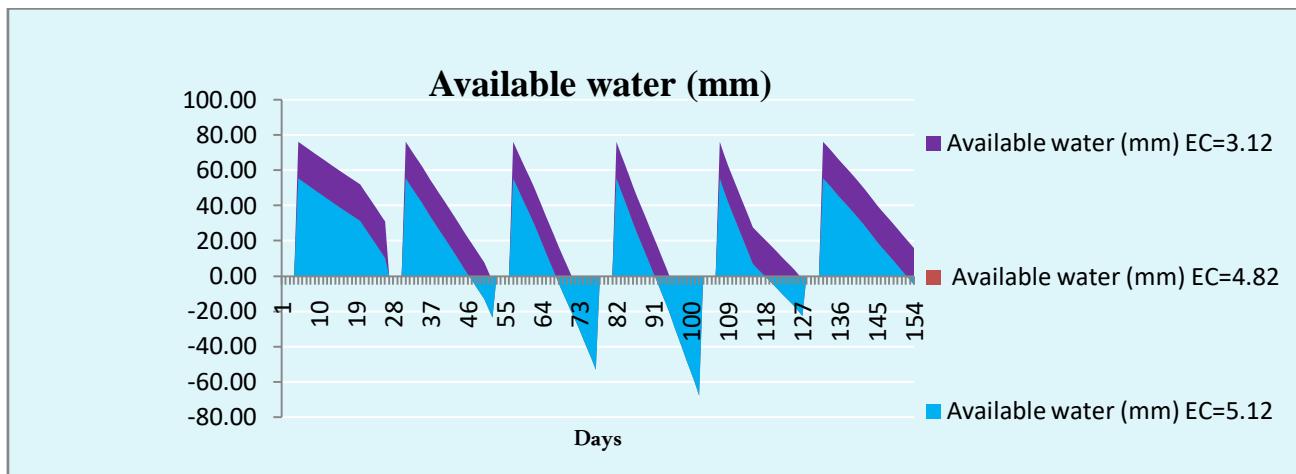

Figure 4.2: Time is a Moisture and Accordingly a Stress Index
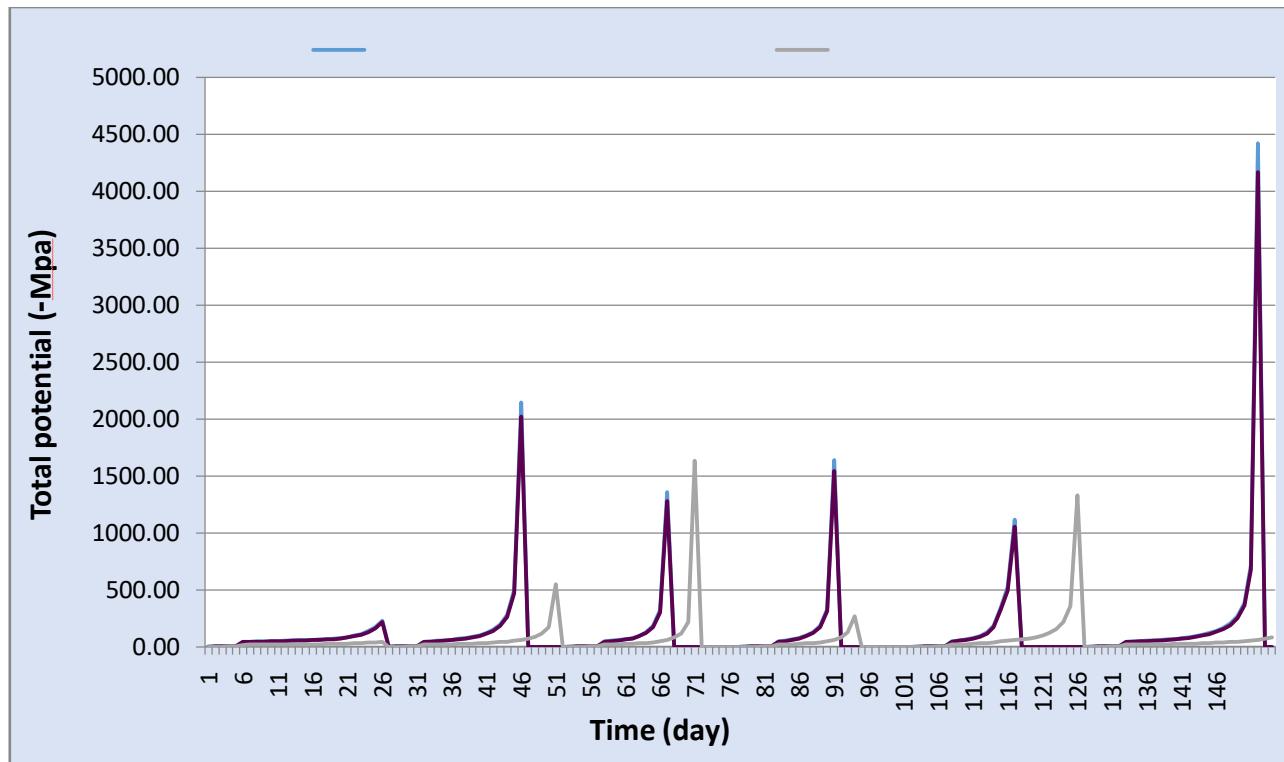
*Figure 4.3:* Time is a Soil Water Potential and Accordingly a Stress Index
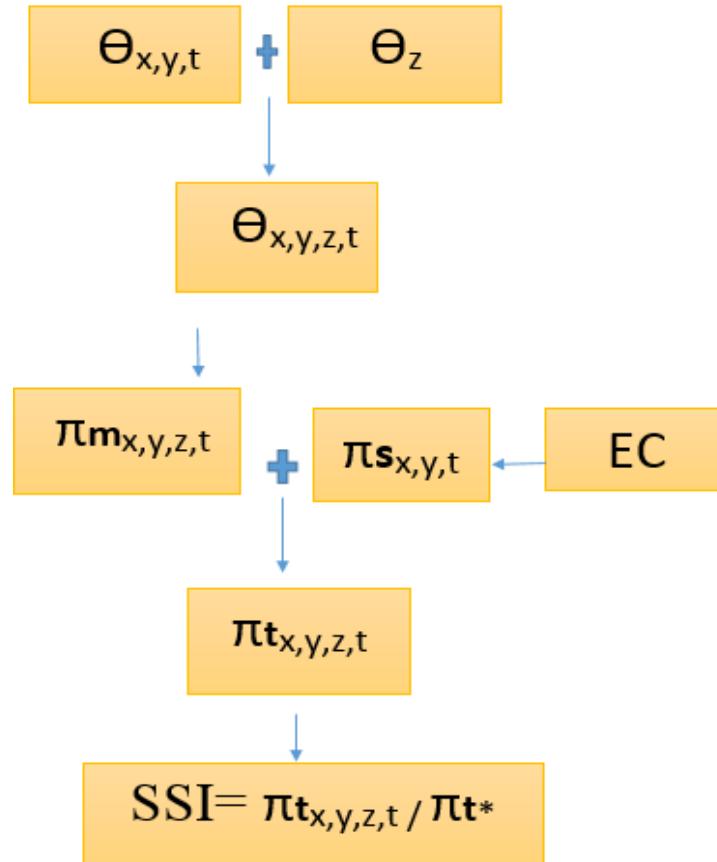
*Figure 4.4:* Schematic Presentation of (SSIMOD)
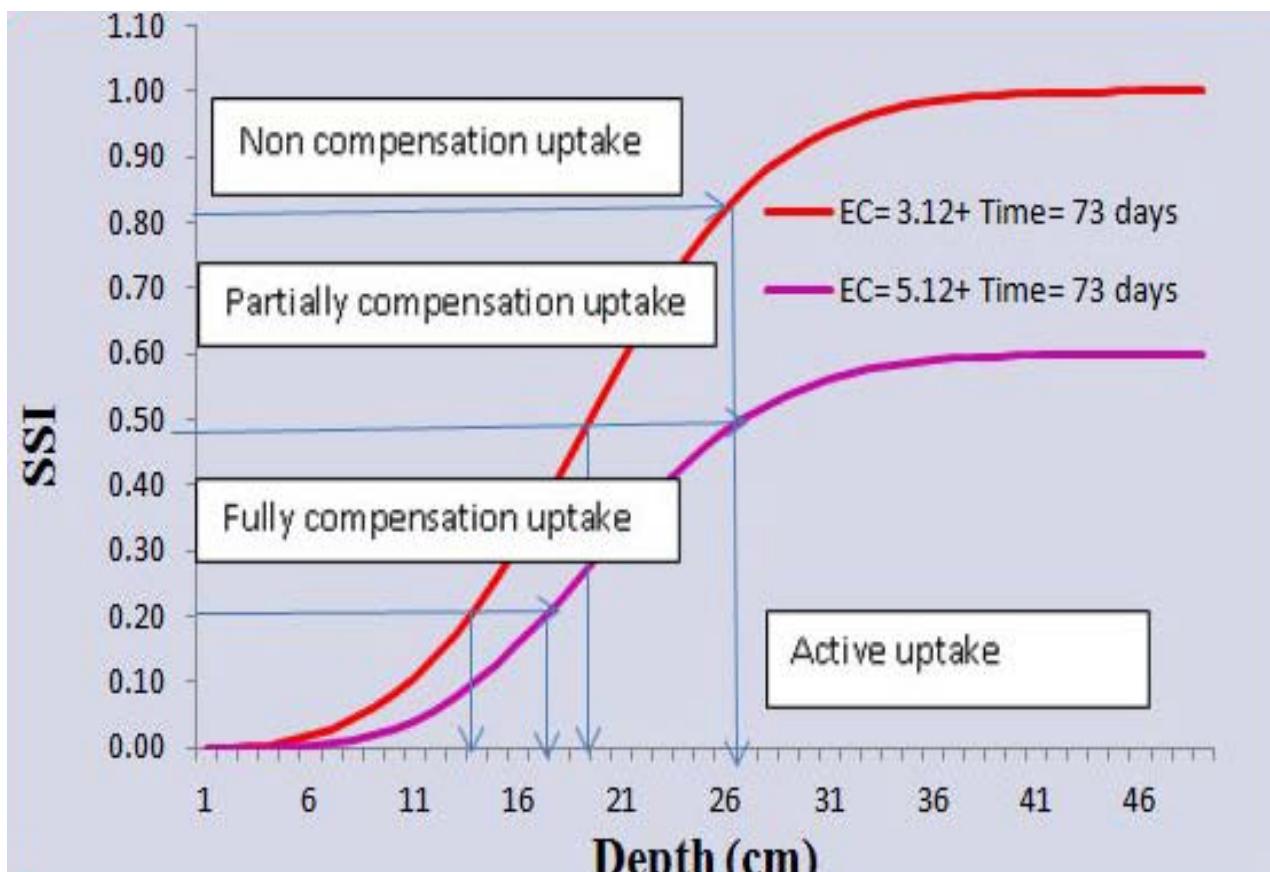
Figure 4.5: Logical Model of SSI

IV. CONCLUSION

AMUN_SHC was modified to calculate the silicon hydraulic capacitance and mass flow passive silicon uptake, AMUN_SiHC. The latter was achieved by replacing β with β_Si. Silicon, is the nutrien element responsible for aiding plants to complete theirs under stress conditions. The concept silicon like hydraulic capacitance indicates that it like to move passively with water path in accordance with soil water hydraulic capacitance. Β and β_Si may distinguish the compensated and uncompensated water and nutrient uptake under saline and drought conditions. The data clearly showed the positive interaction between silicon uptake and soil hydraulic capacitance under abiotic stress conditions. Silicon plays vital roles in reducing the side effects of climatic changes on the agro ecosystem continuum.

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Appendix (1): AMUN_SiHC FORTRAN Code

Symbols:

Mo: soil moisure(v/v), S: soil salinity(ds/cm), PSI: plant astress index, dSSI: change in SSI, AVG: average PSI, KS: saturated hydraulic conductivity(cm/day), hfc: optimum conditiond of total soil potential due to plant species, growth stage, and soil type, Ta: actual transpiration (mm/day). Ta_cum: cumulative tanspiration, Pr_Ta: predicted actual transpiration, Tp: potential transpieration (mm/day).b, βn: soil and silicon hydraulic capacitance, respectively, hs: soil water potential (mpa),hr = root water ptential(mpa).dh: total potential (mpa). Mp, op: mattric and osmotic potential (mpa) respectively. Con: soil silicon concentration (ppm), C: water holding capacity. PCWU: partially compenstaed water uptake, FCWU: fully compenstaed water uptake, PCSIU: partially compenstaed, silicon uptake, FCSIU: fully compenstaed silicon uptake, UCWU: uncompensted water uptake, UCSIU: un compenstaed silicon uptake, Si_pas: silicon passive uptake, Si_pas_cum: cumulative silicon passive uptake, Ob_ PSI: observed plant stress index, AMUN_Si_acc: AMUN_SiHC_accuracy for predicting Si uptake, AMUN_PSI_acc: AMUN_SiHC_accuracy for predicting PSI, AMUN_Ta_acc: AMUN_SiHC_accuracy for predicting actual transpiration, TSi: observed cumulative Si uptake.

```
PROGRAM AMUN_SiHC
IMPLICIT NONE
REAL, DIMENSION(:,:), ALLOCATABLE :: MO, S, SSI,PSI
INTEGER z,I,J,dJ,t,Min,sec,dSec,IERR
REAL dssi, AVG, KC, hfc ,B ,B1 , B2 , hs, ht,
dh,Mp,Op,Ex,Wy,Zs,Zp, c,con, Bn, TP
REAL PCWU, PCSIU, FCWU, FCSIU, UCWU, UCSIU,
PrSi_pascum,PrSi_pas, pr_Tacum
REAL          AMUN_Si_up_acc,          TSi,          Pr_Ta,
```

```
AMUN_Tacum_acc,Ob_Tacum
Ex=0
WY=0
Zs=0
zp=0
I=1
dssi=0
avg=0
kc=0
Tp=0
ht=0
dh=0
B1=0
B2=0
con=0
c=0
PCWU=0
PCSIU=0
FCWU=0
FCSIU=0
UCWU=0
UCSIU=0
Ob_Tacum=0
PR_Tacum=0
WRITE (*,*) 'inter   hfc,   dssi,   avg,   kc,
c,con,I,J,dJ,Min,sec,dSec '
READ (*,*)  hfc, dssi, avg, kc, c,con,I,J,dJ,Min,sec,dSec
ALLOCATE (Mo(Z,T),S(Z,T))
OPEN(UNIT=7,FILE='Amun_in.txt',status=
'unknown',IOSTAT=IERR)
OPEN(UNIT=77,FILE='Amun_out.txt')
READ (7,*) ((Mo(Z,T),S(Z,T),Z=I,J,dJ),T= min,sec,dsec)
DO Z=I,J,dJ
DO T= min,sec,dsec
DO WHILE (IERR.GE.0)
MO(I,J)= Ex
Mp=(Ex)*0.0174
S(I,J)=Wy
op=(Wy)*0.036
hs=Op+Mp
dh=hs- ht
ht=hs
SSI(Z,T)= hs/hfc
SSI(Z,T)=Zs
dssi= SSI(Z+1,T)-SSI(Z+1,T)
PSI(Z,T)=(Avg * kc*dSSI/zs)+(Avg)
PSI(Z,T)= zp
B1= (zp*Tp)/ Zs
B2= (1/Zs)*(((kc*dh)-kc)-(c*dh))
B= (B1+B2)/2
Bn= B * con
IF (B .LT.tp)THEN
PCWU=B*Zs
PR_Ta=PCWU
PR_Tacum=PR_Tacum+ PR_Ta
PCSIU=Bn* Zs
```

```
PCSIU=PrSi_pas
PrSI_pascum= PrSI_pascum+ PrSi_pas
WRITE(77,*)"PCWU,PCSIU,SSI,PSI,B,Bn,PrSi_pas,
PrSi_pas_cum =", PCWU,PCSIU,SSI,PSI,B,Bn,PrSi_pas,
PrSi_pascum
ELSEIF (B.GT.Tp)THEN
 FCWU=B*Zs
PR_Ta=FCWU
PR_Tacum=PR_Tacum+ PR_Ta
 FCSIU=Bn* Zs
PrSi_pas= FCSIU
PrSI_pascum= PrSI_pascum+ PrSi_pas
 WRITE(77,*)"FCWU,SSI,PSI,                         B,Bn,
PrSi_pas,PrSi_pas_cum      =",FCWU,SSI,PSI,     B,Bn,
PrSi_pas,PrSi_pascum
ELSE
 UCWU=B* Zs
PR_Ta=UCWU
PR_Tacum=PR_Tacum+ PR_Ta
 UCSIU=Bn* Zs
PrSi_pas= UCSIU
PrSI_pascum= PrSI_pascum+ PrSi_pas
WRITE(77,*)"         UCWU,SSI,PSI,         B,Bn,PrSi_pas,
PrSi_pas_cum=       ",UCWU,SSI,PSI,     B,Bn,PrSi_pas,
PrSi_pascum
11 format(1x,f7.4,1x)
END IF
END DO
END DO
END DO
WRITE(77,*)" Predicted Si Uptake= ", PrSi_pascum
WRITE(77,*)" Observed Si Uptake= ", TSi
WRITE(77,11) (MO(I,J)),(S(I,J)),(SSI(I,J)),(PSI(I,J))
CalLsaln(S,TSi)
AMUN_Si_up_acc = (( PrSi_pascum)/ TSi)*100
PR_Tacum= PR_Tacum+ PR_Ta
AMUN_Tacum_acc=(PR_Tacum/ Ob_Tacum)*100
Write (77,*) " AMUN_SHC Accuracy Tacum, SI uptake=",
AMUN_Tacum_Acc,AMUN_Si_up_acc
DEALLOCATE (MO),(S),(SSI),(PSI)
END AMUN_SiHC
SUBROUTINE SALN(S,TSi)
REAL S,TSi
WRITE (*,*) "Inter Salinity Level"
READ S
DO WHILE (3.0 .GE.S .AND. S.LE. 6.0)
TSi=-59.7*S**2 + 206*S + 85.84
END DO
RETURN
END
REAL FUNCTION Ob_Ta(Ahr,Ahs,Ar)
!Ahr: ROOT TOTAL POTENTIAL(MPa)
!Ahs: TOTAL SOIL POTENTIAL(MPa)
!AR: HYDRAULIC RESISTANCE
IMPLICIT NONE
REAL Ar,ks, Ahs,Ahr,Ob_Ta, Ob_Tacum
```

```
DIMENSION Ahs(:,:),Ahr(:,:)
INTEGER  z,t, i, j, dj, min, sec, dsec
WRITE(*,*) "INTER ks, i, j, dj, min, sec, dsec"
READ  ks, i, j, dj, min, sec, dsec
OPEN(UNIT=777,FILE='AMUN_SiHC_in.txt')
!OPEN(UNIT=7777,FILE='AMUN_SiHC_OUT.txt')
ks=0
DO z = i,j,dj
DO t = min,sec,dsec
READ (777,*) Ahs(z,t),Ahr(z,t)

AR= dj/ks
DO WHILE (Ahs(z,t) <Ahr(z,t))
Ob_Ta= (Ahr(z,t)-Ahs(z,t))*10197.44/AR
Ob_Tacum= Ob_Tacum+Ob_Ta
END DO
 END DO
END DO
RETURN
END
```

Appendix (1): Boxes

BOX (1):

Mass Balance Method for Solving the Equation of Water Flow.
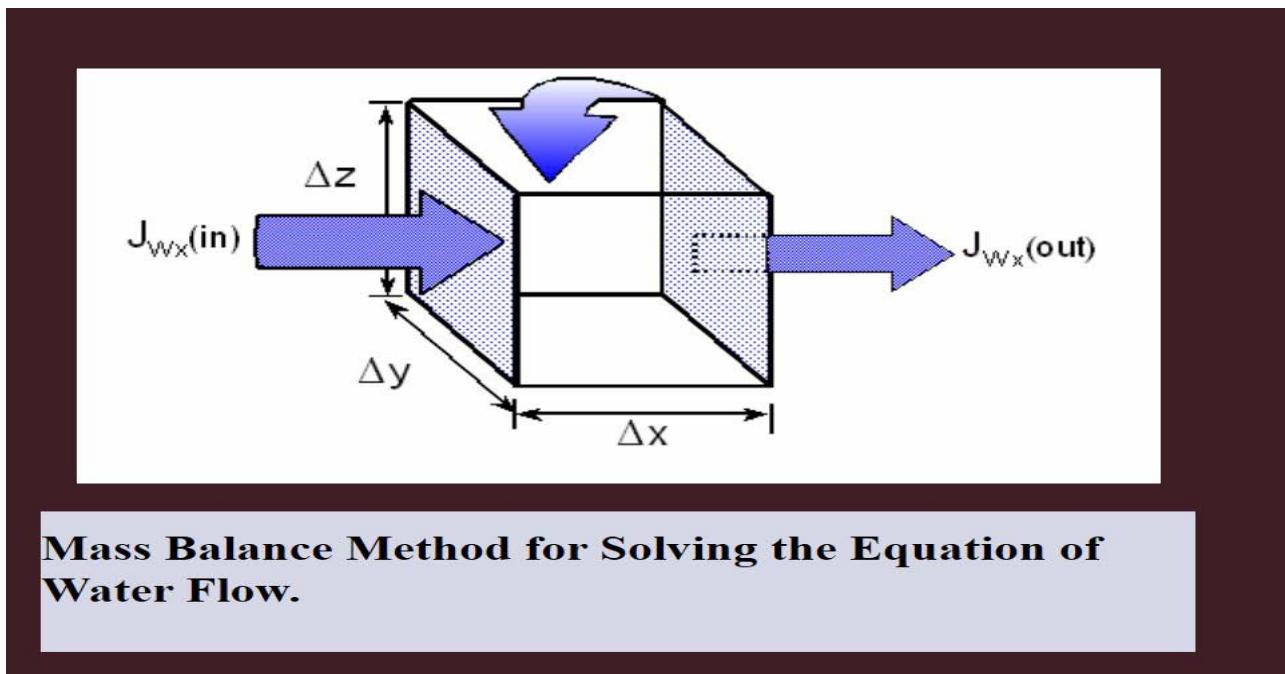
Mass Balance Method

A. $(Q_{in}= Q_{out})=$ Accumulation

$Q_{in}= q_{in}. A = q_{i-1}. A$

$Q_{out=} q_{out}. A. = q_{i}. A$

$Q_{in}= Q_{I-1}= -A. K. [\frac{hi - hi-1}{dx}]$

$Q_{out}=Q_I = -A. K. [\frac{hi+1 - hi}{dx}]$

Accum. $= -A. K. [\frac{hi - hi-1}{dx} - \frac{hi+1 - hi}{dx}]$

$(\theta_i^{j+1}- \theta_i^j)/\Delta t= -A. K. [\frac{h(i-1)-2hi+h(i+1)}{\Delta x2}]$

BOX (2):

Finite Volume Method

$$C(\psi)\frac{\partial\psi}{\partial t} - \nabla.K(\psi)\nabla\psi + \frac{\partial K(\psi)}{\partial z} = 0 \text{ Pressure-based} \quad (1)$$

$$\frac{\partial\theta}{\partial t} - \nabla.D(\theta)\nabla\psi + \frac{\partial K(\theta)}{\partial z} = 0 \text{ Moisture-based} \quad (2)$$

$$\frac{\partial\theta}{\partial t} - \nabla.K(\theta)\nabla\psi + \frac{\partial K(\psi)}{\partial z} = 0 \text{ Mixed-form} \quad (3)$$

A Portion of 1-D Grid
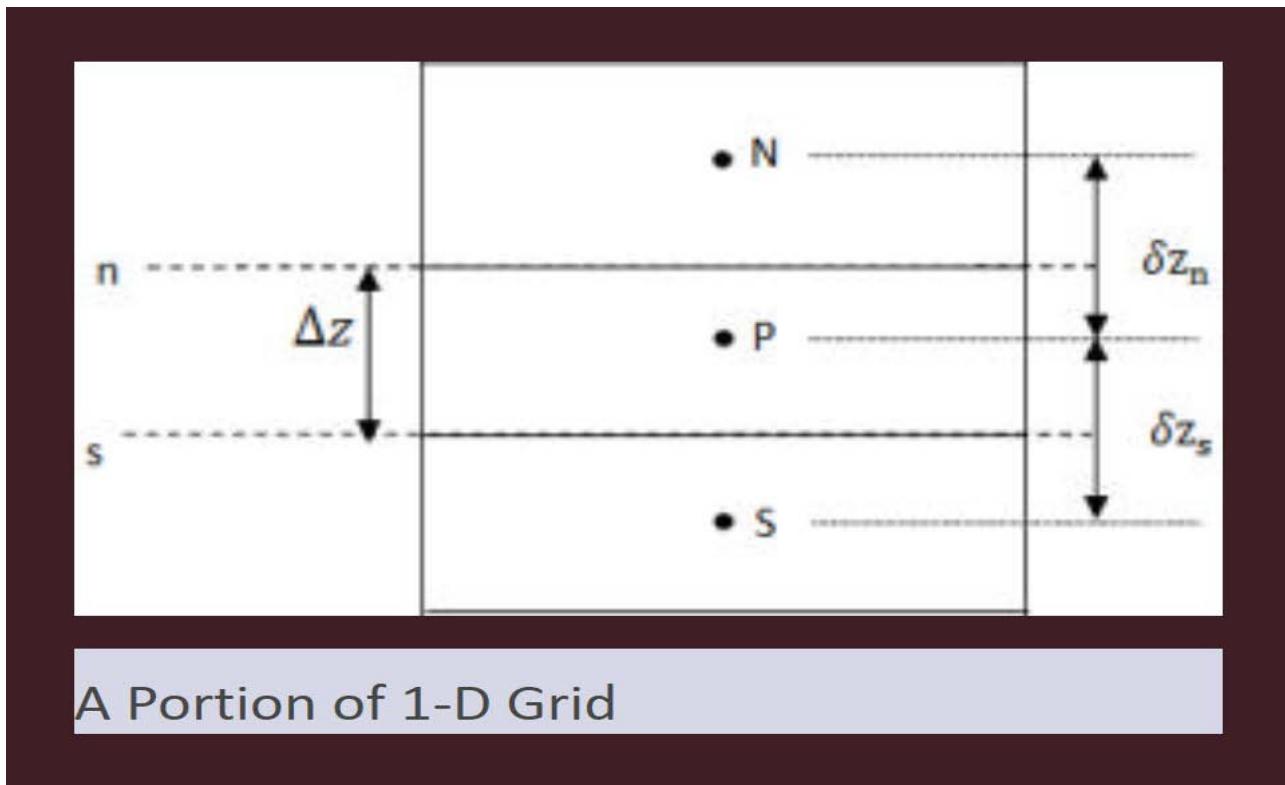
BOX (3):

$$\frac{\partial \theta}{\partial t} - \frac{\partial}{\partial z}\left(K\frac{\partial \psi}{\partial z} + k \right) = 0 \tag{4}$$

The control volume integration, which forms the key step of the finite volume method that distinguishes it from finite difference technique, for the control volume defined above, yields the following form:

$$\int_{n}^{s}\int_{t}^{t+\Delta t} \frac{\partial \theta}{\partial t} dtdz - \int_{t}^{t+\Delta t}\int_{n}^{s}\frac{\partial}{\partial z}\left(K\frac{\partial \psi}{\partial z} + K \right) dzdt = 0 \tag{5}$$

Integrating from first term of this equation respect to time

$$\int_{n}^{s}\int_{t}^{t+\Delta t} \frac{\partial \theta}{\partial t} dtdz = \int_{n}^{s} (\theta^{t+\Delta t} - \theta^{t}) dz \tag{6}$$

50

In finite volume method, the whole specification of fluid and media is constant in a control volume. Therefore, equation 6 converts to follow equation:

$$\int_n^s \int_t^{t+\Delta t} \frac{\partial \theta}{\partial t}\, dt\, dz = (\theta_p^{t+\Delta t} - \theta_p^t)\Delta z \qquad (7)$$

After integrating from second term of equation 5, the result would be:

$$\int_t^{t+\Delta t}\int_n^s \frac{\partial}{\partial z}\left(K\frac{\partial \psi}{\partial z} + K\right)dz\,dt = \int_t^{t+\Delta t}\left[\left(K\frac{\partial \psi}{\partial z}+K\right)_s - \left(K\frac{\partial \psi}{\partial z}+K\right)_n\right]dt \qquad (8)$$

BOX (4):

For implicit solution, the discretized form of (4)

$$(\theta_p^{t+\Delta t} - \theta_p^t)\Delta z = \left[\left(K^t\frac{\partial \psi^{t+\Delta t}}{\partial z}+K^t\right)_s - \left(K^t\frac{\partial \psi^{t+\Delta t}}{\partial z}+K^t\right)_n\right]\Delta t \qquad (9)$$

where θ^t and K^t denotes the value of θ and K at time t, respectively, Dt is the time step, Y^{t+Dt} denotes the Y at time t+Dt and the solution is assumed to be known at time level t and unknown at time level t+Dt. Because the velocity of water flow in soil is very small, it is logical to consider hydraulic conductivity is constant during a time step.

$$\left(K^t \frac{\partial \psi^{t+\Delta t}}{\partial z} + K^t\right)_s = K_s^t \frac{\psi_s^{t+\Delta t} - \psi_p^{t+\Delta t}}{\delta z_s} + K_s^t \qquad (10)$$

$$\left(K^t \frac{\partial \psi^{t+\Delta t}}{\partial z} + K^t\right)_n = K_n^t \frac{\psi_p^{t+\Delta t} - \psi_n^{t+\Delta t}}{\delta z_n} + K_n^t \qquad (11)$$

Substitution of equations (10) and (11) into (9) gives:

$$(\theta_p^{t+\Delta t} - \theta_p^t)\Delta z = \left[\left(K_s^t \frac{\psi_s^{t+\Delta t} - \psi_p^{t+\Delta t}}{\delta z_s} + K_s^t\right) - \left(K_n^t \frac{\psi_p^{t+\Delta t} - \psi_n^{t+\Delta t}}{\delta z_n} + K_n^t\right) \right]\Delta t \qquad (12)$$

For solution (10) an iterative method must be used. Considering 'm' as iteration level and using Picard iterative method, gives:

BOX (5):

$$(\theta_p^{t+\Delta t, m+1} - \theta_p^t)\Delta z = \left[\left(K_s^t \frac{\psi_s^{t+\Delta t, m+1} - \psi_p^{t+\Delta t, m+1}}{\delta z_s} + K_s^t\right) - \left(K_n^t \frac{\psi_p^{t+\Delta t, m+1} - \psi_n^{t+\Delta t, m+1}}{\delta z_n} + K_n^t\right) \right]\Delta t \qquad (11)$$

There are two unknowns vector θ and Y in 'm+1'th iteration level. As proposed by researchers, for predicting $\theta_p^{t+Dt,m+1}$, a Taylor series is expanded as follow [12]:

$$\theta_p^{t+\Delta t, m+1} = \theta_p^{t+\Delta t, m} + \left(\frac{d\theta}{d\psi}\right)_p^t (\psi_p^{t+\Delta t, m+1} - \psi_p^{t+\Delta t, m}) \qquad (12)$$

In a uniform grid $Dz = dz_s = dz_n$ and (10) can be re-arranged as:

$$\alpha \psi_n^{t+\Delta t} + \beta \psi_p^{t+\Delta t} + \gamma \psi_s^{t+\Delta t} = \lambda \qquad (13)$$

where

$$\alpha = K_n^t \left(\frac{\Delta t}{\Delta z^2} \right)$$

$$\beta = -\left[(K_n^t + K_s^t) \left(\frac{\Delta t}{\Delta z^2} \right) + C_p^t \right]$$

$$\gamma = K_s^t \left(\frac{\Delta t}{\Delta z^2} \right)$$

and

$$\lambda = \left[(K_n^t - K_s^t) \left(\frac{\Delta t}{\Delta z} \right) \right] - C_p^t \psi_p^{t+\Delta t, m} + (\theta_p^{t+\Delta t, m} - \theta_p^t)$$

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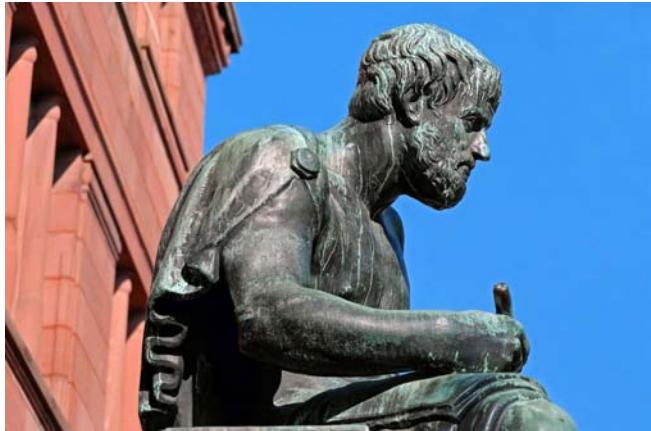
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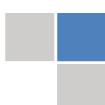
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To the institution

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Career	Credibility	Exclusive	Reputation

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Career	Credibility	Exclusive	Reputation

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Career	Credibility	Exclusive	Reputation

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Career	Credibility	Reputation

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`Career` `Financial`

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Exclusive   Financial

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Associate	Fellow	Research Group	Basic
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Gradation of Research	**Gradation** of Research	**Gradation** of Research	
10 research contacts/day	**Unlimited** research contacts/day	**Unlimited** research contacts/day	
1 GB Cloud Storage	**5 GB** Cloud Storage	**Unlimited** Cloud Storage	
GJ Community Access	**Online Presense** Assistance	**Online Presense** Assistance	
	GJ Community Access	GJ Community Access	

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We accept the manuscript submissions in any standard (generic) format.

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2. Drafting the paper and revising it critically regarding important academic content.
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Acknowledgments

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The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

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It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.
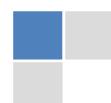
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Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

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Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

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Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

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- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

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Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.
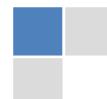
The following approach can create a valuable beginning:

o   Explain the value (significance) of the study.
o   Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
o   Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
o   Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

o   Report the method and not the particulars of each process that engaged the same methodology.
o   Describe the method entirely.
o   To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
o   Simplify—detail how procedures were completed, not how they were performed on a particular day.
o   If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

o   Resources and methods are not a set of information.
o   Skip all descriptive information and surroundings—save it for the argument.
o   Leave out information that is immaterial to a third party.
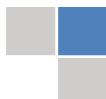
Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- o   Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- o   In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- o   Present a background, such as by describing the question that was addressed by creation of an exacting study.
- o   Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- o   Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- o   Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- o   Do not include raw data or intermediate calculations in a research manuscript.
- o   Do not present similar data more than once.
- o   A manuscript should complement any figures or tables, not duplicate information.
- o   Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
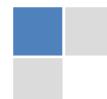
Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

o You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
o Give details of all of your remarks as much as possible, focusing on mechanisms.
o Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
o One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
o Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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