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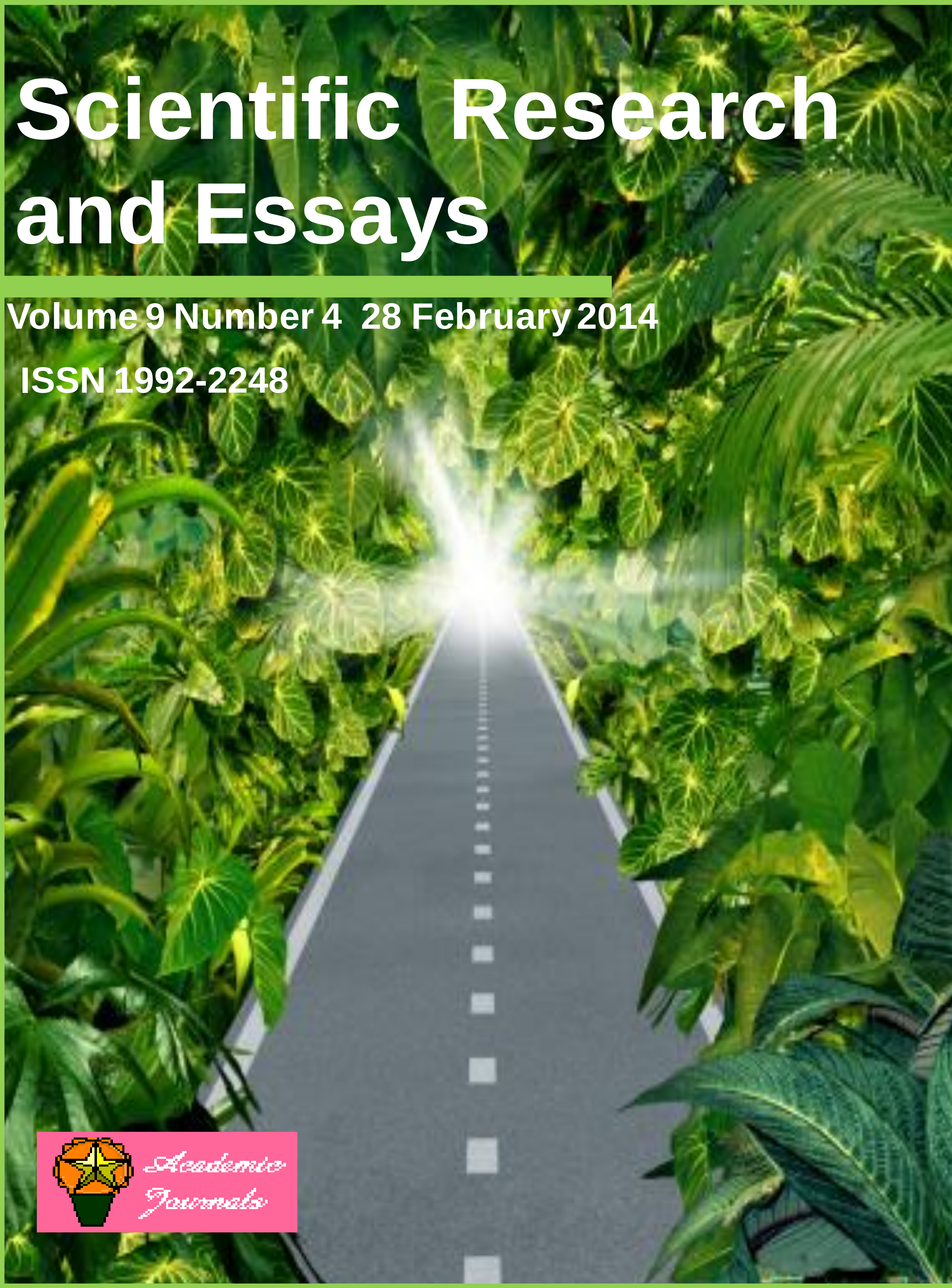

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Charnley AK (1992). Mechanisms of fungal pathogenesis in insects with particular reference to locusts. In: Lomer CJ, Prior C (eds) Biological Controls of Locusts and Grasshoppers: Proceedings of an international workshop held at Cotonou, Benin. Oxford: CAB International, pp 181-190.

Mundree SG, Farrant JM (2000). Some physiological and molecular insights into the mechanisms of desiccation tolerance in the resurrection plant Xerophyta viscasa Baker. In Cherry et al. (eds) Plant tolerance to abiotic stresses in Agriculture: Role of Genetic Engineering, Kluwer Academic Publishers, Netherlands, pp 201-222.

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Scientific Research and Essays

Review

A review on Oat (*Avena sativa* L.) as a dual-purpose crop

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The multifunctional uses of oats include forage, fodder, straw for bedding, hay, haylage, silage chaff, human food; most commonly, they are rolled or crushed into oatmeal, or ground into fine oat flour. Oatmeal is chiefly eaten as porridge, but may also be used in a variety of baked goods, such as oatcakes, oatmeal cookies, oat bread and raw material for food, health care and cosmetic products. The major components of oats that contribute to its function include *β*-glucan, protein, oil, and starch. The minor protein of oat is a prolamine, avenin. In addition there are minor components, including tocols and avenanthramides that have antioxidant properties and may contribute to human health and well being. Here we review the progress made in oats and highlight the potential and future prospects.

Key words: Fodder, forage, food, *β*-glucan, protein, tocols, avenanthramides, health.

INTRODUCTION

Oats rank around sixth in the world cereal production statistics following wheat, maize rice, barley and sorghum. Oat grain has always been an important form of livestock feed. Oats are an annual plant and can be planted either in autumn (for late summer harvest) or in the spring (for early autumn harvest). Known locally as "jau", oats are grown on the foothills of Himalayas, such as in the India State of Himachal Pradesh. They are a good source of protein, fibre, and minerals but world oat grain declined as farm mechanization increased between 1930 to1950. Oats remain an important grain crop for people in marginal ecologies throughout the developing world, and in developed economies for specialist uses. In many parts of the world oats are grown for use as grain as well as for forage and fodder, straw for bedding, hay, haylage, silage and chaff. Livestock grain feed is still the primary use of oat crops, accounting for an average of around 74% of the world's total usage in 1991 to 1992 (Welch, 1995). Oats are better adapted to variable soil types and can perform better on acid soils than other small grain cereals crops. They are mostly grown in cool moist climates and they can be sensitive to hot, dry weather from head emergence through to maturity. For these reasons, world oat production is generally concentrated between latitudes 35 to 65°N, including Finland and Norway, and 20 to 46°S. Most of the world's production comes from spring sown cultivars, but autumn sowing is practiced along the higher altitude regions, including the Himalayan Hindu Kush range and in regions where summers are hot and dry. Where winters are

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Table 1. Top ten oats producers in 2013 (Thousand metric tons).

European Union	7,581
Russia	4,027
Canada	2,680
Australia	1,050
United States	929
Ukraine	630
Belarus	600
China	580
Chile	560
Argentina	400
World Total	20,732

Source: United States Department of Agriculture (2013).

severe, such as in Scandinavia, northern states of the US, Canada, and higher altitude regions in the tropics, short season to mid maturing oat cultivars are generally sown. In regions with temperate climates, oats are variously spring, winter and/or autumn sown depending on regional climatic conditions, crop rotation requirements, end use and other farming practices. In warmer regions, spring type oats sown in autumn to avoid summer heat and drought.

Russia, countries of the former Soviet Union, the US, Canada, Germany and Poland (Table 1) account for about 75% of the world's supply of grain oats, seed and industrial grade oats. Since the 1960s the proportion of oats used for feed has declined in the US and Canada, remained unchanged in the former Soviet Union countries and Poland, and increased slightly in Germany.

Oats consumed as feed in the US are becoming a specialty feed for race horses, hobby farmers and breeding stock. The leading exporters of oat grain are Canada, Finland, Sweden Australia, and Argentina. The US, Japan, the former Soviet Union, Switzerland and the European Union are the principal importers of oat grains.

A significant proportion of the oat grains and forages produced on smaller more remote farms around the world, including in the Himalayan region, are consumed on the farm and never enter the commercial market place. A case study from Nepal (Stevens et al., 2000) covering oats dating back to the 1950s, shows how people in Pakistan, Afghanistan and China could benefit substantially from access to better performing cultivars to alleviate poverty and improve human and animal nutrition. These examples highlight the need for a co-ordinate international fodder oat network targeting resource-poor environments in the relatively remote communities.

Oats are grown for use as grain as well as forage and fodder, straw for bedding, hay, haylage, silage and chaff. Food uses for oats include oatmeal, oat flour, oat bran and oat flakes for use as breakfast cereals and ingredients in other food stuffs. Oats are one of the most nutritious grain cereals, high in protein and fibre. The protein of rolled (flakes) oats is generally greater than that found in other cereal grains. Many of the vitamins and minerals found in oats are combined in the bran and germ. Most oat food products use the entire groat, making it a nutritious cereal grain. In India, oats have a wider adaptability, particularly in western and north western regions of the country because of its excellent growing habitats, quick re-growth and better nutritional value. Only a few varieties of oats are available for cultivation and their grain yields under good management conditions vary between 15 to 25 q ha^{-1}. Development of high yielding varieties of oats, therefore, assumes a greater significance for human consumption (Ahmad and Zaffar, 2014).

USES OF OAT

Animal feed

Oats are grown for use as grain as well as forage and fodder, straw for bedding, hay, haylage, silage and chaff. Oat is an important winter fodder, mostly fed as green but surplus is converted into silage or hay to use during fodder deficit periods (Suttie and Reynolds, 2004). Oat as a forage crop has the advantage of being winter hardy and serves as catch crop (Morey, 1961). It is preferred feed of all animals and its straw is soft and grain is also valuable feed for horses, dairy cows, poultry and young breeding animals. The demand of meat, beef, milk, butter and their byproducts is increasing due to rapidly growing human population in India. Oat protein is nearly equivalent in quality to soy protein, which has been shown by the World Health Organization to be equal to meat, milk, and egg protein. In J&K State livestock population is 7.8 million so the fodder production is not sufficient enough to meet the requirements of a burgeoning livestock population (Anonymous, 2009). The farmers face fodder deficiency in winter when they have only dry stalks of summer cereal fodders or dry summer grasses. In order to increase in productivity *per* unit area there is need to develop varieties having higher forage yield potential and quality. Interest in oat hay for the dairy, feedlot and horse industries has grown in recent years. This is mainly due to improvement in oat hay quality brought about by higher quality standards demanded by the export hay market (Lush, 1945). Inadequate supply of quality feed and fodder is the primary cause of lower productivity of milch animals in India (Patel et al., 2011). In Jammu and Kashmir, fodder requirement is about 4.31 against the availability of 3.26 million tones, there by having deficient of 1.05 million tones on dry matter basis (Anonymous, 2008). Kashmir valley experienced a long lean period of winter, resulting in scarcity of green and quality fodder which results in drastic decrease in milk and milk production. Therefore,

Table 2. Nutritional value per 100 g.

Energy	1,628 kJ (389 kcal)
Carbohydrates	66.3 g
Dietary fibre	10.6 g
Fat	6.9 g
Protein	16.9 g
Pantothenic acid (B_5)	1.3 mg (26%)
Folate (vit. B_9)	56 μg (14%)
Calcium	54 mg (5%)
Iron	5 mg (38%)
Magnesium	177 mg (50%)
Potassium	429 mg (9%)
β-glucan (soluble fibre)	4 g

Source: United States Department of Agriculture (2013).

to meet the need of animal products and to maintain good health and potential of livestock in terms of milk, meat and wool, there is a great importance of fodder cultivation to compensate the fodder scarcity during lean period. The present production is not proportionate with the demand. So, oats deserves a deep deliberation for improvement. It should be highly pragmatic by the fact that, sixty corers animals will need 1097 and 1170 million tonnes of green fodder, respectively. Deficiency of green fodder will be about 64.9% and for dry fodders it may go to up to 24.9% in 2025 A.D (Government of India Planning Commission, 2001). It should pave the way for bringing about a kind of plant type, which could enhance its quality and productivity without sacrificing the consumer needs. Cultivation of high yielding fodder oat cultivar Sabzaar developed for temperate climatic conditions of Kashmir valley have helped in enhancing forage productivity but in order to further increase in productivity *per* unit area there is need to develop varieties having higher forage yield potential and quality. Understanding the gene action and combining ability may help in choosing suitable breeding procedure for improvement of forage oat. So, there is an urgent need of exploiting new research technologies to boost forage yield in terms of higher yield of green fodder and dry matter per unit are. The competition for utilization of land for food grains and fodder necessitates intensified efforts towards more efficient forage production. The forage oat varieties having higher productivity, better quality and tolerance to abiotic stress is the need of the hour in bridging the gap between demand and supply of green fodder.

Human food

The amount of oats used for human consumption has increased progressively, owing its dietary benefits and nutritional value (Table 2). In fact, the health effects of oat rely mainly on the total dietary fibre and *β*-glucan content (Kerckhoffs et al., 2003). Oat protein is nearly equivalent in quality to soy protein, which has been shown by the World Health Organization to be equal to meat, milk, and egg protein. The protein content of the hull-less oat kernel (groat) ranges from 12 to 24%, the highest among cereals (Lasztity, 1999). The popularity of oatmeal and other oat products again increased after a January 1998 decision by the Food and Drug Administration (FDA), when it issued a final rule that allows food companies to make health claims on food labels of foods that contain soluble fibre from whole oats (oat bran, oat flour and rolled oats), noting that 3.0 g of soluble fibre daily from these foods may reduce the risk of heart disease. Oats are a rich source of soluble fiber, well-balanced proteins and several vitamins and minerals essential for the human health (Esposito et al., 2005). Oats contain relatively high amounts of lipids compared with other cereal grains with a substantial level of essential linoleic acid (Mattila et al., 2005). Additionally, oats are a source of several natural antioxidants such as tocopherols, alk(en)ylresorcinols, and phenolic acids and their derivatives, and a unique source of avenanthramides (N-cinnamoylanthranilate alkaloids) and avenalumic acids (ethylenic homologues of cinnamic acids), which are not present in other cereal grains (Mattila et al., 2005). All of these phenolic compounds possess potential health-promoting properties because of their antioxidant activities and/or membrane-modulating effects (alk(en)ylresorcinols). Moreover, *β*-glucans, which also exhibit an antioxidant property are included in the soluble dietary fibre fractions of oats that participates in glucoregulation and causes a decrease in serum cholesterol levels in humans (Esposito et al., 2005). The consumption of oats is therefore an important component of diet for hypercholesterolemic patients (Czerwiński et al., 2004). In addition to their importance in the diet, oats antioxidants may also contribute to the stability and the taste of food products. Most of the previous studies in literature have reported a good antioxidant capacity of oats (Mattila et al., 2005).

β-Glucan is a soluble fiber readily available from oat grains that has been gaining interest due to its multiple functional and bioactive properties. Its beneficial role in insulin resistance, dyslipidemia, hypertension, and obesity is being continuously documented. The fermentation ability of *β*-glucan and their ability to form highly viscous solutions in the human gut may constitute the basis of their health benefits. Consequently, the applicability of *β*-glucan as a food ingredient is being widely considered with the dual purposes of increasing the fiber content of food products and enhancing their health properties. Therefore, this article explores the role of *β*-glucan in the prevention and treatment of characteristics of the metabolic syndrome, their underlying mechanisms of action, and their potential in food applications. Farming community also get economic benefits from cultivating quality oats thus, quality oat cultivation should be encouraged. The polysaccharides *β*-glucan occurs as a principal component of the cellular walls. Some microorganisms, such as yeast and mushrooms, and also cereals such as oats and barley, are of economic interest because they contain large amounts of *β*-glucan. These substances stimulate the immune system, modulating hum oral and cellular immunity, and thereby have beneficial effect in fighting infections (bacterial, viral, fungal and parasitic). *β*-glucan also exhibit hypocholesterolemic and anticoagulant properties. Recently, they have been demonstrated to be anti-cytotoxic, ant mutagenic and anti-tumorogenic, making them promising candidates as pharmacological promoters of health. The present interest in soluble oat fiber originated from reports that showed that dietary oats can help in lowering cholesterol (Braaten et al.,1994; Baeet al., 2010; Drozdowski et al., 2010; Tiwari and Cummins, 2011), postprandial blood glucose level (Wood et al., 2000; Hooda et al., 2010; Regand et al., 2011; Dong et al., 2011; Tiwari and Cummins, 2011) as well as modifying immune response and reducing risk of colon cancer (Mälkki, 2001; Yang et al., 2008).

Avenanthramides

Avenanthramides consists of an anthranilic acid derivative linked to hydroxycinnamic acid derivative. The three major avenanthramides reported in oat are avenanthramides 1, 3, and 4, which are also known as avenanthramides B, C, and A, respectively (Peterson et al., 2002). Oat flakes have more avenanthramides (26 to 27 µg/g) than oat bran (13 µg/g) (Mattila et al., 2005). These compounds are bioavailable and have anti-inflammatory, anti-atherogenic and antioxidant properties (Peterson et al., 2002).

BENEFITS FROM *Β*-GLUCAN

It is an immune modulator, by binding to surface receptors and causing activation of macrophages, white blood corpuscles, phygocytosis of neutrophil and activation of lymphocytes thus stimulating antitumor and antimicrobial activate. In cosmetics, because *β*-glucan immune functions activate the langerhans cells which induces cytokine, particularly of interleukin-1(il-1) and that stimulates the proliferation of fibro- blasts (skin cells) and synthesis of collagen, elastin and proteoglycan. *β*-glucan thus acts as an anti-aging, skin soothing agent, film forming substance, moisturizing, U-VA protect ant and in wound healing and as anti-irritant. Vascular injury may contribute to the pathogenesis of *β*-glucan such as zymosan has been shown to be beneficial in wound healing and may increase collagen synthesis; the study has shown that *β*-glucan can help the healing of wound in db/db mice. This is related to *β*-actin activation of macrophage. There is also possibility that *β*-glucan could help the healing of vascular injury.

Viscosity related properties

Viscosity is the thickness or resistance to flow of a liquid. Many health related effects of oats result from the high viscosity of their soluble B- glucan. It accomplishes some of the nutritional functions by increasing the viscosity of fluids in the gut. Standard oat varieties contain from 4.5 to 5.0% of *β*-glucan content and has been proposed as a target for oat breeding programmes to double this concentration.

Blood cholesterol and oat *β*-glucan

LDL-cholesterol, which contains the highest concentration of cholesterol, damages blood vessels because of its tendency to infiltrate and accumulate within arterial walls. LDL-cholesterol, and especially small, dense LDL-cholesterol, is also more susceptible to structural modifications including oxidation and glycosylation, which play major roles in the development of atherosclerosis. High concentration of serum high density lipoprotein (HDL)-Cholesterol are protective against CHD, since HDL may scavenge and remove excess cholesterol in the arterial wall and also protect LDL against oxidation.

Reducing cholesterol with oats: the hypocholesterolemic properties of oats were first demonstrated in 1963. Oats were significantly hypocholesterolemic, lowering total and LDL- cholesterol by 2 to 23%. Oats future improves lipid profiles by significantly increasing blood concentrations of HDL cholesterol as well as apolipoprotein A-I, a major component of HDL (Glore et al., 1994).

Diabetes and oat *β*-glucan

Diabetes mellitus is characterized by high blood glucose level with typical manifestations of thirst, polyuria, polydipsia, and weight loss. It is caused by defects in insulin-mediated signal pathways, resulting in decreased glucose transportation from blood into muscle and fat cells. The major risk is vascular injury leading to heart disease, which is accelerated by increased lipid levels and hypertension. Management of diabetes includes: control of blood glucose level and lipids; and reduction of hypertension. Dietary intake of *β*-glucan has been shown to reduce all these risk factors to benefit the treatment of diabetes and associated complications. In addition, *β*-glucan also promotes wound healing and alleviates ischemic heart injury. However, the mechanisms behind the effect of *β*-glucan on diabetes and associated complications need to be further studied using pure *β*-

glucan. Foods rich carbohydrates have high glycemic response or glycemic index (GI) which cause rapid secretion of insulin from pancreas low GI-diet prevents diabetes, cardiovascular disease, metabolic syndrome and obesity. Water-soluble oat B-glucan exerts their effects mainly by increasing viscosity in the small intestine during digestion, resulting in an extended digestion period. When digestion is delayed, blood sugar increases more slowly, causing low insulin response. The oat *β*-glucan form a protective layer along the intestinal wall that acts as a viscous barrier slowing food uptake from the intestine (Mckeown et al., 2004).

Blood pressure and oat *β*-glucan

High blood pressure (BP) is defined as having a systolic BP greater than 140 mm Hg or a diastolic BP greater than 90 mm Hg due to the increasing internal pressure on the artery; hypertension contributes to endothelial injury and increasing CHD risk by enhancing the infiltration of LDL particles. Hypertension also accelerates the transformation of fatty streaks into fibrous plaques by enhancing smooth muscle proliferation. Oats may help maintain healthy blood pressure by improving the glycemic and insulinemic profiles. The DASH (dietary approaches to stop hypertension) study demonstrated that a diet high in whole grains, fruit, vegetable and low fat dairy, and restricted in fat, lowers BP in hypertension individuals. Dietary consumption of oats is consistent with the DASH recommendations, and may confer benefit due to its fiber content (Contreras et al., 2000).

Oat *β*-glucan as prebiotics

The lower part of intestine- the colon, has been identified as a key organ affecting general health. The growth and metabolism of the many individual bacterial species inhabiting the colon depend primarily on the substrates available to them, most of which come from the diet. Oat *β*-glucan, which is indigestible in the small intestine but is fermented by bacteria in the colon, is prebiotics. Prebiotics are non digestible food ingredients that selectively stimulate the growth or activities of bacteria in the colon. They beneficially affect a series of intestine functions by modulating the structure, consumption, and metabolic activity of mucosa and microflora in the colon. The end product created from prebiotics fermentation in the colon are short chain fatty acids, e.g., butyric acid, that serve as nutrients for mucosal cells (Malkki and Virtanen, 2013).

Oat *β*-glucan and weight management

Satiety is a complex bodily sensation that signals that the Stomach is full and it is time to stop eating. When consumed 20 to 30 min before eating a meal, *β*-glucan form a thick viscous fluid in the stomach and small intestine that stimulates the sensation of satiety and help limit appetite. By reducing the desire for food intake, the effect can help in weight control when combined with a healthy, balanced diet and adequate exercise. As a result of the extended period of digestion, nutrients are utilized by the body over a longer period and, thus may contribute to a longer period of satiety in weight management programs. Fiber may impart a textural quality that increases chewing time. Fibbers' have also been reported to prolong gastric emptying, small bowel transit time, and the digestion and absorption of carbohydrates and fat. These actions, which effectively alter glycemic response have been shown to intensify satiety and aid in the control of energy intake. Meals enriched with *β*--glucan elevate plasma levels of cholecystokinin (CCK), a hormone that mediates fat-induced satiety. Faber may also increase fecal energy excretion. Oat protein has also been found to be more satiating than energetic amounts of carbohydrates or fat (Ludwig, 2000).

Oat and celiac disease

Celiac disease is an autoimmune hereditary disorder of the small intestine that occurs because of sensitivity to gluten in food. Normally the lining of the small intestine has a fluffy velvety texture, but in celiac disorder it becomes smooth and flat. This reduces its ability to absorb nutrients, including sugars, proteins, vital minerals and vitamins from food. When persons with celiac disease take food containing gluten, their immune system responds by damaging the small intestine lining. They fingerlike protrusions, called villi are attacked by the immune system and are eventually destroyed. Malnutrition occurs without these villi; no matter how much food a person consumes, because the nutrients from food pass the gastrointestinal tract (GIT) without being absorbed (malabsorption), leading to diarrhoea, vitamin and mineral deficiencies, anemia, osteoporosis and intestine cancer presently. The only effective treatment of celiac disease is a life-long reliance on gluten-free diet. The injurious constituent of wheat in patients with celiac disease is α-gliadin in the prolamin fraction of wheat gluten. Oats do not contain gliadin and its counterpart is avenin. Oats improve the nutritional value of the gluten-free diet without any negative effect on nutritional status and are appreciated by the patients. Inclusion of oats in the gluten free diet is advantageous, since oats are a good source of dietary fiber and of several and minerals (Huttner and Arendt, 2010).

Oat *β*-glucan prevents cancer

β-glucans have been used in immune-adjuvant therapy for cancers and tumors since 1980. The ability of *β*-glucan to inhibit tumor growth in a variety of experimental tumor models is well established (di Luzio et al., 1979). Many of the scientific studies and published articles were done primarily in Japan. There is a large collection of research data that demonstrates *β*-glucans have antitumor and anticancer activity. Generally, the (1, 3)-*β*-glucan was administered prophylactically and the end-point were tumor growth, tumor volume, degree of metastases, and/or survival. Moreover, the antitumor efficacy of (1, 3)-*β*-glucan seems to relate to the type of tumor, the genetic background of the host animal, the dose, the route, and timing of *β*-glucan administration, as well as the tumor load. Antitumor and anticancer effect of *β*-glucan is not just macrophages that attack tumor cells and destroy them, but also modulation of lymphocyte, neutrophil, and natural killer (NK) cells activity and other components of the innate immune system (Hong et al., 2004).

Oat milk

Oat milk is a tasty, nutritious and cheaper alternative to dairy milk. Western herbalists regard oats as a tonic for the nervous system. It has high fiber, zero fat, vitamin E, folic acid, phytochemicals (*β*-carotene), cholesterol and lactose free.

Industrial benefits

Viscosity properties of *β*-glucan can be used in the Bakery industry in products such as biscuits and pastas. Its use could also include frozen desserts, breakfast foods, beverages, meats, on-dairy creamers, and canned soups, especially as fat replacer. The cheese industry can benefits from *β*- glucan which optimize the process of raw material and improves the cheese structure. The combination of insulin and *β*–glucan also has very interesting properties that can be used as fat-replacer in products such as low-fat ice-creams. This has been proved to be very successful dietary sources of the soluble fibre *β*-glucan and has been associated with a reduced risk for many diseases.

Other benefits

Medicinally oats have been used to prevent heart disease and cancers, to enhance immune response to infection and to stabilize blood sugars. They have also been used to treat rheumatism, chronic neurological pain and atonia (weakness) of the bladder. They have been used to treat insomnia, stress, anxiety, depression and nervous exhaustion. Interestingly, an extract of oats was used in traditional Ayurvedic medicine to cure opium addiction. A case report showed 6 out of 10 opium addicts gave up the drug after a treatment period of 27 to 45 days using a decoction of green oats. Oats have also even been used to treat withdrawal from tobacco. Oat straw in particular is a tonic when taken medicinally. It has been prescribed by herbalists to treat general debility and a wide range of nervous conditions gently raising energy levels while supporting an over-stressed nervous system. Infusions of oat straw have also been used for flu and coughs. These uses may or may not have been sanctioned by relevant government bodies or authorities. Oats have a soothing effect on skin. A decoction added to a bath helps soothe dry skin or itchiness, including such conditions as eczema, psoriasis measles, chickenpox, pityriasis rosea and sunburn. Oats can also be used as a skin cleanser and are frequently used as an exfolliant to remove the surface layer of dead skin cells. Oats are therefore a common ingredient in many skincare preparations. Oats can be found in bars of soap as well as in creams and gels. Some oat extracts have been found to have a synergistic sun-blocking effect when used in combination with titanium dioxide. Hydrolysed oat protein has been a popular ingredient in shampoos and conditioners, in particular as a replacement for animal-derived proteins, and it has been reported that the proteins condition and coat damaged hair, prevent hair dryness and improve hair texture. Use for oat starches has been proposed, including as a replacement for talcum powder, which has been linked with various adverse health effects. In combination with certain other oat derivatives the starch may be formulated into dusting powders for surgical gloves containing both smoothness and anti-irritant properties (Ulmiu et al., 2012). Oat hulls are a raw material for the making of furfural (from the latin word *furfur*, meaning bran) and many related compounds (furfuryl alcohol, tetrahydrofurfuryl alcohol, furan, tetrahydrofuran and polytetramethylene etherglycol). Industrial uses of furfural and these compounds includes solvent extraction of crude petroleum, the nylon industry, a solvent for dyes, resins, paints, and varnish, production of elastomers and thermoplastics, manufacture of phenolic resin glues and plywood adhesives, hydrogen peroxide explosives, anti-skid tread composition, as a filter aid in breweries, production of construction board material and production of paper pulp. The starches in oats have also been used in the production of adhesives. Another patented use of oats is an oil spill dispersant which is able to absorb oil, then emulsify and disperse it efficiently. Oat flour can be converted into starch acetates that are used in the production of biodegradable plastics. Oat proteins can be used as carriers and release agents for agricultural chemical sprays. Oat hulls can also be used as growing substrates for yeast and fungi; the production of chemical indicators of toxicity in polluted water; the production of xylitol (a sugar substitute). Oats may also prove to be a good source of the enzyme lipase, which breaks down fat. Oats are an annual grass that is high in calcium. Calcium rich foods and herbs are the basis for remedies that relax the muscles and nervous system. *Avena sativa* should be thought of as the basis for every good nerve relaxing formula. Oatmeal or gruel is an ideal food for convalescents and can be flavored with raisins, lemon, butter, or maple syrup. It is easily digested and is a soothing food for those with fever and a good first food for those who have experienced intestinal illnesses or food poisoning. Oatmeal is an excellent alternative to eggs and sausages or bacon for those desiring a low fat, low cholesterol breakfast routine. The alcohol tincture of Oat straw can be used for nerve complaints and for uterine problems in the standard dose of ten to twenty drops, taken in water, three times a day. Oat straw tea is recommended by herbalists to soothe chest complaints, especially when mixed with a little lemon and honey. A strong brew can be added to the bath to benefit rheumatism, paralysis, liver ailments, gout, and kidney problems. Bladder and bowel conditions, intestinal colic and bedwetting have all been helped by soaking in a bath of Oat Straw. These effects of oat *β*-glucan were well reviewed by Mälkki and Virtanen (2001), Ulmius et al. (2011), Wang et al. (2002) and Dikeman et al. (2006).

CONCLUSION

Kashmir valley has experienced a long lean period of winter, resulting in scarcity of green and quality fodder which results in drastic decrease in milk and milk production. Therefore, to meet the need of animal products and to maintain good health and potential of livestock in terms of milk, meat and wool, there is a great importance of fodder cultivation to compensate the fodder scarcity during lean period. Development of high yielding varieties of oats therefore, assumed greater importance for human consumption and animal health and also Kashmir valley is ideally suitable for oats cultivation because of its temperate climate. For scientific utilization of elite allelic resources present in the exotic gene pool of oats through hybridization and subsequent selection of recombinants possessing high grain yield potential together with high *β*-glucan, it is imperative to characterize these genotypes on scientific basis. Genotypes having high *β*-glucan content can be used in breeding programmes for increasing the *β*-glucan content of adapted local germplasm. Avena Atlantic genotypes have highest *β*-glucan concentration (2.2 to 11.3%) and are useful source for increasing the *β*-glucan content of cultivated oats. Besides, conventional methods, mapping population have been developed and genomic region associated with *β*-glucan content have been identified. Molecular markers linked to *β*-glucan content and other quality traits have been mapped to dissect the genomic regions contributing to the quality traits.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Ahmad M, Zaffar G (2014). Evaluation of oats (*Avena sativa* L.) genotypes for *β*-glucan, grain yield and physiological traits. Appl. Biol.l Res. 16(1):1-3.
Anonymous (2008). Status paper on fodder production in the state of Jammu and Kashmir. Paper presentation 41st RCM (Rabi 2008), SKUAST-K, Shalimar, Srinagar, J&K, India.
Anonymous (2009). Digest of Statistics (2009-2010). Directorate of Economics and Statistics, Planning & Development Department, Government of J&K, Srinagar pp. 94-100.
Bae IY, Kim SM, Lee S, Lee HG (2010). Effect of enzymatic hydrolysis on cholesterol-lowering activity of oat beta-glucan. N. Biotechnol. 27(1):85-8.
Braaten JT, Wood PJ, Scott FW, Wolynetz MS, Lowe MK, Bradley-White P, Collins MW. (1994). Oat β–glucan reduces blood cholesterol concentration in hypercholesterolemic subjects. Eur J Clin Nutr. 48:465-74.
Contreras F M, Rivera J, Vasquez MA, De la Parte and Velasco M (2000). Diabetes and hypertension patho physiology and therapeutics. J. Hum. Hyper.1:26-31
Czerwiński J, Bartnikowska E, Leontowicz H (2004). Oat (*Avena sativa* L.) and amaranth (*Amaranthus hypochondriacus*) meals positively affect plasma lipid profile in rats fed cholesterol-containing diets. J. Nutr. Biochem. 15:622-629.
di Luzio NR, Williams DL, Mcnamee RB, Edwards BF, Kitahama A. (1979). Comparative tumor inhibitory and anti-bacterial activity of soluble and particulate glucana. Int. J. Cancer. 24:773-779.
Dikeman CL, Murphy MR, Fahey GC Jr. (2006). Dietary fibers affect viscosity of solutions and simulated human gastric and small intestinal digesta. J. Nutr. 136(4):913-919.
Dong JL, Cai FL, Shen RL, Liu Y (2011). Hypoglycemic effects and inhibitory effect on intestinal disaccharidases of oat beta-glucan in streptozotocin-induced diabetic mice. Food Chem. 129:1066-1071.
Drozdowski LA, Reimer RA, Temelli F, Bell RC, Vasanthan T, Thomson ABR (2010). *β*-Glucan extracts inhibit the in vitro intestinal uptake of long-chain fatty acids and cholesterol and down-regulate genes involved in lipogenesis and lipid transport in rats. J. Nutr. Biochem. 21(8):695-701.
Esposito F, Arlotti G, Bonifati AM (2005). Antioxidant activity and dietary fibre in durum wheat bran by-products. Food Res. Int. 38:1167–1173.
Glore SR, Van Treeck D, Knehans AW, Guild M (1994). Soluble fiber and serum lipids: a literature review. J. Am. Diet Assoc. 94:425-436.
Govt of India, Planning Commission. (2001).
Hong F, Yan J, Baran JT, Allendorf DJ, Hansen RD, Ostroff GR, Xing PX, Cheung NK, Ross GD (2004). Mechanism by which orally administered *β*-(1, 3)-glucans enhance the tumoricidal activity of antitumor monoclonal antibodies in murine tumor models. J. Immunol. 173(2):797-806.
Hooda S, Matte JJ, Vasanthan T, Zijlstra RT (2010). Dietary purified oat *β*-glucan reduces peak glucose absorption and portalinsulin release in portal-vein catheterized grower pigs. Livest Sci. 134(1–3):15-7.
Huttner EK, Arendt EK (2010). Recent advances in gluten-free baking and the current status of oats, Trends in Food Sci. Technol. 21:303-312.
Kerckhoffs D, Hornstea G, Mensink R (2003). Cholesterol lowering effect of beta-glucan from oat bran in mildly hypercholesterolemic subjects may decrease when beta-glucan is in corporated into bread and cookies. Am. J. Clin. Nutr. 78:221-227.
Lasztity R (1999). General characterization of the chemical composition of cereal grains. The structure of the cereal grain. *In cereal chemistry*, Akademiai Kiado. Budapest, pp. 13-24.
Ludwig DS (2000). Dietary glycemic index and obesity. J. Nutr. 130:280S-283S.
Lush JL (1945). Animal Breeding Plans.3rd edition. Iowa State University

Press, Ames Iowa, pp.125-138.
Malkki Y, Virtanen E (2013). Gastrointestinal effects of oat bran and oat gum: Areview. Lebensm-Wiss. Technol. 34:337-347.
Mattila P, Pihlava JM, Hellstrom J (2005). Contents of phenolic acids, alkyl- and alkenylresorcinols, and avenanthramides in commercial grain products. J. Agric. Food Chem. 53:8290-8295.
Mckeown NM, Meigs JB, Liu S, Saltzman E, Wilson PWF, Jacques PF (2004). Carbohydeate nutrition, insulin resistance, and the prevalence of the metabolic syndrome in the Framinghm offspring Cohort. Diabets Care. 27:538.
Morey DD (1961). Forage production of small grains under maximum favourable condition. Agron. J. 53: 57-59.
Patel TU, Arvadia MK, Malik PK, Patel DD, Patel PS (2011). Production of oats (*Avena Sativa*.L) under different cutting management and split application of nitrogen. Indian Journal of Agronamy, 56:164-167.
Peterson DM, Hahn MJ, Ammonds CL (2002). Oat avenanthramides exhibit antioxidant activities in vitro. Food Chem. 79:473.
Regand A, Chowdhury Z, Tosh SM, Wolever TMS, Wood P. (2011). The molecular weight solubility and viscosity of oat beta-glucan affect human glycemic response by modifying starch digestibility. Food Chem. 129:297-304.
Stevens EJ, Wright SC, Pariyar D, Shrestha KK, Munakarmi PB, Mishra CK, Muhammad D and Han J (2000). The importance of oats in resource-poor environments. *Proceeding of the 6th International Oat Conference,* Christchurch New Zealand. P. 74.
Suttie JM, Reynolds SG (2004). Fodder Oats: A World Overview. FAO, http://www.fao.org/docrep/008/y5765e/ y5765e00.htm.
Tiwari U, Cummins E (2011). Meta-analysis of the effect of beta-glucan intake on blood cholesterol and glucose levels. Nutr. 27(10):1008–1016.
Ulmius M, Adapa S, Önning G, Nilsson L (2012). Gastrointestinal conditions influence the solution behaviour of cereal *β*-glucans in vitro. Food Chem. 130(3):536-40.
Ulmius M, Johansson-Persson A, Immerstrand Nordén T, Bergenståhl B, Önning G (2011). Gastrointestinal release of *β*-glucan and pectin using an in vitro method. Cereal Chem Doi: 10.1094/CCHEM-11--10--0169.
Wang Q, Wood PJ, Cui W (2002). Microwave-assisted dissolution of *β*-glucan in water-implications for the characterization of this polymer. Carbohydr Pol. 47(1):35-38.
Welch RW (1995). The Oat Crop: Production and Utilization. ed. Chapman and Hall, UK. P. 584.
Wood PJ, Beer MU, Butler G (2000). Evaluation of the role of concentration and molecular weight of oat *β*-glucan in determining effect of viscosity on plasma glucose and insulin following an oral glucose load. Br J Nutr.pp. 8419-8423.
World oats production, consumption, and stocks .*United States Department of Agriculture*. Retrieved 18 March 2013.
Yang JL, Jang JH, Radhakrishnan V, Kim YH, Song YS. (2008). *β*-Glucan suppresses LPS-stimulated NO production through the down-regulation of iNOS expression and NFkB transactivation in RAW 264.7 macrophages. Food Sci. Biotechnol. 17:106-113.

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Scientific Research and Essays

Full Length Research Paper

Comparative performance analysis of irrigation schemes in Kastamonu area located in northern Turkey

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Performance analysis of six irrigation schemes in Kastamonu area located in northern Turkey were assessed using comparative performance indicators between the years 2008 and 2012. Performance indicators used for the analysis included relative water supply, financial performance as cost recovery ratio, maintenance expenditure to revenue ratio, operational cost per unit area, total cost per personnel employed on water delivery, revenue collection performance and service area per personnel. Additionally, production performance of the schemes were evaluated in terms of output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit consumed-water. The results of the analysis indicated that all irrigation schemes except Asar had enough performance for the relative water supply ratios. Furthermore, cost recovery ratio and revenue collection performance was not satisfactory. On the other hand, maintenance expenditure to revenue, operational cost per unit area, total cost per person employed on water delivery and service area per personnel had performed well in most of schemes during the study years. Output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit consumed-water were performed well for all schemes in the investigation year.

Key words: Comparative analysis, irrigation performance, performance indicators, irrigation schemes.

INTRODUCTION

Agriculture is a very important key for the socio-economic development of Turkey. Fresh water supply is the principle component of the agricultural practices in arid and semi-arid regions of Turkey. Thus the most important challenges for the management of agricultural lands is efficient use of fresh water resources in the region (Sayın et al., 2013).

Pressures on watersheds due to diverse demands with rapid increase in populations and the lack of homogeneity in the distribution of water sources put the situation worse in some part of the country (Çakmak and Aküzüm, 2006).

Currently, less than 60% of potential 8.5 million ha of irrigable agricultural land are under irrigation condition in Turkey. And about 90% of these irrigated lands have gravity irrigation systems (Öztürk, 2004).

Performance of irrigation schemes needs to be analyzed to assess the efficiency of the system (Molden and Sakthivadivel, 1999). Studies in different regions of Turkey used multidisciplinary performance indicators such as water delivery, water use efficiency, sustainability of irrigation, environmental and socio-economic aspects and management are required in order to determine the

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Table 1. Irrigation schemes in the study area.

Irrigation facility	Starting date for operation	Date of transfer	Type of irrigation organization
Asar	2009	3/2/2010	Asar Irrigation Association
Beyler	2006	31/10/2009	Beyler Irrigation Association
Germeçtepe-Kırcalar	2003	7/1/2004	Germeçtepe-Kırcalar Irrigation Association
Hasköy	2007	18/09/2008	Hasköy Irrigation Association
Karaçomak	2004	15/03/2004	Karaçomak Irrigation Association
Karaderer	2007	24/08/2010	Karadere Irrigation Association

Figure 1. Map showing the WUAs location in Kastamonu area in northern Turkey

performance of the irrigation schemes in all aspects (Akkuzu et al., 2007; Uçar et al., 2010).

Mengü and Akkuzu (2010) studied about the effects of the transfer of irrigation management on water and land productivity, and water supply in Gediz Basin in Aegean Sea Region of Turkey. In this study, researchers found out that there was a decline in water supply indicators with a steady increase in the productivity of water. They determined that the reason for this decrease in supply is the long-lasting and ongoing drought in the region.

Kukul et al. (2008) assessed the temporal variations of agricultural, water use, environmental and financial performance indicators for the pre transfer (1984 to 1994) and the post transfer (1995 to 2004) periods. They found a considerable increase in output per unit of land and per unit of water after turnover. According to results of this study, the transfer process created more sustainable management for irrigation. Study by Dorsan et al. (2004) in the same basin showed the similar results.

Değirmenci et al. (2003) evaluated irrigation system performance for irrigation schemes in Southeastern Anatolia Project (GAP) region in Turkey. Study showed that an information system for monitoring and evaluation which encompasses all stakeholders should be set up and irrigation scheduling should be designed for efficient and rational irrigation management.

The temporal variations of physical and economic performance were assessed in the irrigation schemes in Thrace region of Turkey by Şener (2012). In this study, it was concluded that the irrigation management transfer program increased the system performance and the schemes have become more self-sufficient under the management of Water User Associations (WUAs).

There is no study previously carried out on irrigation performance evaluation of irrigation schemes in Kastamonu region. Therefore, the aim of this study is to assess water delivery performance, financial performance and productive performance on irrigation schemes using the data acquired from the WUAs in Kastamonu region situated in northern Turkey for the years 2008 to 2012.

MATERIALS AND METHODS

In this study, WUAs namely Asar, Beyler, Germeçtepe-Kırcılar, Hasköy, Karaçomak and Karadere serving under the twenty-third State Hydraulic Works (SHW) Regional Directorate were assessed (Table 1). The twenty-third SHW Regional Directorate is geographically located in Kastamonu Area in Turkey (Figure 1). Its service area covers the watersheds of İncesu, Şadibey, Karadere, Karaçomak and Daday Stream. Asar Lake is also in this service area. Annual average precipitation during study years in the searched area is about 625 mm (Anonymous, 2013).

Data on irrigation area, irrigated land, water diverted to schemes, irrigation water requirement, cropping pattern, yield and unit prices of the crops grown for the years 2008 to 2012 were taken from evaluation and monitoring reports of the related WUAs (Table 2). The prices of products were converted from Turkish Lira to American Dollars using the Central Bank of Turkish Republic's foreign exchange rate.

In this study, the International Program for Technology and Research in Irrigation and Drainage (IPTRID) approach is used for performance evaluation in the irrigation and drainage sector. The comparative analysis of performance indicators used in performance assessment of irrigation schemes are given in Table 3 (Malano and Burton, 2001). Related data for performance evaluation were taken from the records of the SWH 23th Regional Directorate in Kastamonu.

RESULTS AND DISCUSSION

Irrigation ratios of schemes between 2008 and 2012

Table 2. Characteristics of evaluated irrigation schemes in Kastamonu area of Turkey.

Name of irrigation	Water resource	Irrigation area (ha)	Conveyance and distribution network	Cropping pattern	Irrigation management	Type of irrigation system
Asar	Asar Lake	1010	Closed System	Garden, Sugar Beet, Vegetables and Poplar	Pressurized	Pumping
Beyler	İncesu Stream	5178	Open Canal	Sugar Beet, Corn, Broom Grass, Potatoes and Forage Crops	Surface	Gravity
Germeçtepe-Kırcalar	Şadibey Stream	2196	Open Canal	Sugar Beet, Corn, Broom Grass, Fruit, Vegetable, Poplar and Forage Crops	Surface	Gravity
Hasköy	Karaçomak and Daday Stream	2580	Open Canal	Cereals, Garden, Sugar Beet, Corn, Broom Grass, Fruit, Vegetables, Forage Crops and Poplar	Surface	Gravity
Karaçomak	Karaçomak Stream	1670	Open Canal	Sugar Beets, Corn, Broom Grass, Fruit, Potato, Onion, Garlic, Forage Crops and Poplar	Surface	Gravity and Pumping
Karaderer	Karadere Stream	5810	Open Canal and Closed System	Cereals, Garden, Sugar Beet, Corn, Broom Grass, Fruit, Vegetables, Forage Crops and Poplar	Surface and Pressurized	Gravity and Pumping

Table 3. Comparative analysis of performance indicators used in the case study and data required.

Activity area	Performance indicator	Data required
Water delivery performance	Annual relative water supply	Total annual inflow volume to system/Volume of annual crop water requirement
Financial performance	Cost recovery ratio	Total revenue collected from water users/Total management, operation and maintenance (MOM) cost
	Maintenance expenditure to revenue ratio	Total maintenance expenditure/Total revenue collected from water users
	Operational cost per unit area ($ ha^{-1})	Total operation expenditure/Total command area serviced by the system
	Total cost per person employed on water delivery ($/person)	Total cost of MOM personnel/Total number of people employed
	Revenue collection performance	Total service revenue collected/Total service revenue due
	Service area per personnel (ha/person)	Total number of MOM staff/Total command area serviced by system
Productive performance	Output per unit command area ($ ha^{-1})	Gross value of agricultural production/Total cultivable command area
	Output per irrigated area ($ ha^{-1})	Gross value of agricultural production /Total irrigated crop area
	Output per unit irrigation supply ($ m^{-3})	Gross value of agricultural production/Total inflow volume of water
	Output per unit water consumed ($ m^{-3})	Gross value of agricultural production/Total volume of water consumed by crop

according to the records of the SWH in the study area are given in Table 4. Ratios are similar to study reported by Nalbantoğlu and Çakmak (2007) but are not similar to results of works by Yercan et al. (2004) due to regional conditions.

The ratio of maximum relative water supply was about 13 in Asar in 2012 while the minimum ratio of that was 1 in Germeçtepe-Kırcalar in 2009 (Table 5). Most of the results for water supply ratios in this area are higher than previous studies (Kukul et al., 2008). Water was diverted to system as needed when the relative water supply ratio equal to 1. Moreover, water was diverted to system with higher and lower amount for the relative water supply ratio value of higher than 1.0 and lower than 1.0, respectively (Beyribey, 1997). At this point, all values of relative water supply ratio of study equal and higher than 1. There is no problem for water diverted to system for all schemes in this study. The higher water was diverted to Asar scheme in all the schemes.

Cost recovery ratio was maximum in the Karadere irrigation scheme with 136% in 2011, and minimum in the Karaçomak irrigation scheme with 14% in 2008 (Table 6). Data indicated that the total revenue collected from water users were not sufficient to meet the maintenance

Table 4. Irrigation ratios of WUAs in the study area.

Irrigation schemes	Irrigation area (ha					Irrigated area (ha)					Irrigation ratios (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	1010	1010	1010	NA	NA	144	100	67.00	NA	NA	14.3	9.9	6.6
Beyler	NA	NA	5178	5178	5178	NA	NA	310	338	702.00	NA	NA	6.0	6.5	13.6
Germeçtepe-Kırcalar	2100	2100	2100	2196	2196	709	423	675	678	663.00	33.8	20.1	32.1	30.9	30.2
Hasköy	NA	2580	2580	2580	2580	NA	348	632	496	439.00	NA	13.5	24.5	19.2	17.0
Karaçomak	1670	1670	1670	1670	1670	407	376	440	475	501.00	24.4	22.5	26.3	28.4	30.0
Karaderer	NA	NA	NA	5810	5810	NA	NA	NA	744	1633.00	NA	NA	NA	12.8	28.1

NA: Not available.

Table 5. Relative water supply ratios of WUAs in the study area.

Irrigation schemes	Total water input to system (m^3)					Total irrigation water need (m^3)					Relative water supply ratios				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	4038000	2202000	2842000	NA	NA	490000	337000	222000	NA	NA	8.2	6.5	12.8
Beyler	4993000	2447000	2143000	4445000	5113000	965000	478000	966000	1024000	1857000	5.2	5.1	2.2	4.3	2.8
Germeçtepe-Kırcalar	2907000	1048000	3182000	4983000	6873000	1603000	1046000	2093000	1978000	1792000	1.8	1.0	1.5	2.5	3.8
Hasköy	NA	4256000	5345000	4811000	4575000	NA	867000	1756000	1401000	1186000	NA	4.9	3.0	3.4	3.9
Karaçomak	3457000	2842000	4937000	5573000	6716000	1154000	1950000	1297000	1375000	1379000	3.0	1.5	3.8	4.1	4.9
Karaderer	NA	NA	NA	7065000	10755000	NA	NA	NA	2235000	4419000	NA	NA	NA	3.2	2.4

NA: Not available.

Table 6. Cost recovery ratios of WUAs in the study area.

Irrigation schemes	Total revenue collected from water users (US$)					Total maintenance operational management cost (US$)					Cost recovery ratios (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	11966.7	6547.6	5500.6	NA	NA	13066.7	13947.6	12008.4	NA	NA	91.6	46.9	45.8
Beyler	NA	NA	26892.0	14636.9	43340.4	NA	NA	80192.0	78075.0	81128.1	NA	NA	33.5	18.7	53.4
Germeçtepe-Kırcalar	39578.9	26110.4	50760.0	64232.7	71844.9	186274.2	103451.3	168000.0	109324.4	114896.1	21.2	25.2	30.2	58.8	62.5
Hasköy	NA	44607.8	55713.3	17857.1	56751.1	NA	42835.1	73640.7	79488.7	75379.8	NA	104.1	75.7	22.5	75.3
Karaçomak	24375.0	23647.4	42562.0	28279.8	36713.5	178196.9	93056.5	112284.0	108560.1	99817.4	13.7	25.4	37.9	26.0	36.8
Karaderer	NA	NA	NA	91611.3	119551.1	NA	NA	NA	67252.4	167769.1	NA	NA	NA	136.2	71.3

NA: Not available.

Table 7. Maintenance expenditure to revenue ratio values of WUAs in the study area.

Irrigation schemes	Total maintenance cost (US$)					Total revenue collected from water users (US$)					Maintenance expenditure to revenue ratio (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	0.0	3218.5	3089.9	NA	NA	11966.7	6547.6	5500.6	NA	NA	0.0	49.2	56.2
Beyler	NA	NA	7236.7	10285.1	8036.0	NA	NA	26892.0	14636.9	43340.4	NA	NA	26.9	70.3	18.5
Germeçtepe-Kırcalar	16468.8	19513.0	16475.3	13095.2	13277.0	39578.9	26110.4	50760.0	64232.7	71844.9	41.6	74.7	32.5	20.4	18.5
Hasköy	NA	7175.3	10407.3	8285.7	9080.3	NA	44607.8	55713.3	17857.1	56751.1	NA	16.1	18.7	46.4	16.0
Karaçomak	12750	14961.0	21732.0	20895.8	16612.4	24375.0	23647.4	42562.0	28279.8	36713.5	52.3	63.3	51.1	73.9	45.2
Karaderer	NA	NA	NA	6742.3	34321.3	NA	NA	NA	91611.3	119551.1	NA	NA	NA	7.4	28.7

NA: Not available.

Table 8. Operational cost per unit area of the WUAs in the study area.

Irrigation schemes	Total maintenance operational management cost (US$)					Irrigation area (ha)					Operational cost per unit area (US$ ha^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	13066.7	13947.6	12008.4	NA	NA	1010	1010	1010	NA	NA	12.9	13.8	11.9
Beyler	NA	NA	80192.0	78075.0	81128.1	NA	NA	5178	5178	5178	NA	NA	15.5	15.1	15.7
Germeçtepe-Kırcalar	186274.2	103451.3	168000.0	109324.4	114896.1	2100	2100	2100	2196	2196	88.7	49.3	80.0	49.8	52.3
Hasköy	NA	42835.1	73640.7	79488.7	75379.8	NA	2580	2580	2580	2580	NA	16.6	28.5	30.8	29.2
Karaçomak	178196.9	93056.5	112284.0	108560.1	99817.4	1670	1670	1670	1670	1670	106.7	55.7	67.2	65.0	59.8
Karaderer	NA	NA	NA	67252.4	167769.1	NA	NA	NA	5810	5810	NA	NA	NA	11.6	28.9

NA: Not available.

operation management costs. However, Beyribey (1997) determined that cost recovery ratios of state irrigation schemes and average of the country were between 21 to 91% and 65%, respectively.

The highest and lowest maintenance expenditure to revenue ratios were obtained in the Germeçtepe-Kırcılar irrigation scheme with 75% in 2009 and Karadere irrigation scheme with 7.4% in 2011, respectively (Table 7). Nalbantoğlu and Çakmak (2007) reported maintenance expenditure to revenue ratios between 2.5 and 11%. Their results are lower than those of the current study. However, revenue collected from water users were enough to maintenance costs in the most of schemes between 2008 and 2012 (Table 7).

Concerning the operational cost per unit irrigation area, the highest cost per unit area was obtained from the Karaçomak irrigation scheme with US$ 107 ha^{-1} in 2008 while the lowest cost was acquired in the Karadere irrigation scheme with US$ 12 ha^{-1} in 2011 (Table 8). In the study of Çakmak et al. (2010), operational cost per unit irrigation area was between US$ 6.5 ha^{-1} and US$ 71 ha^{-1}. Most of schemes in this study have higher values than that of a reported study by Çakmak et al. (2010). However values are similar to the study conducted by Nalbantoğlu and Çakmak (2007). Operational cost per unit irrigation area was higher at the beginning of the study. But in the following years it started to decline, thanks to decreasing of total maintenance operational

Table 9. Cost per personnel employed in the WUAs.

Irrigation schemes	Total cost of maintenance-operating-management personal (US$)					Total number of people employed person					Cost per personnel (US$ person^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	3466.7	3095.2	2106.7	NA	NA	2	3	2	NA	NA	1733.3	1031.7	1053.4
Beyler	NA	NA	35143.3	36183.9	41067.4	NA	NA	24	1	3	NA	NA	1464.3	36183.9	13689.1
Germeçtepe-Kırcalar	47415.6	44064.9	32900.0	47760.1	28089.9	9	9	10	10	11	5268.4	4896.1	3290.0	4776.0	2553.6
Hasköy	NA	18107.8	30161.3	29441.7	31011.2	NA	9	9	9	10	NA	2012.0	3351.3	3271.3	3101.1
Karaçomak	49710.9	39563.0	39071.3	47648.2	38679.8	7	7	7	8	7	7101.6	5651.9	5581.6	5956.0	5525.7
Karaderer	NA	NA	NA	37381.0	69053.4	NA	NA	NA	10	14	NA	NA	NA	3738.1	4932.4

NA: Not available.

Table 10. Revenue collection performance of the WUAs in the study area.

Irrigation schemes	Total collected water fee from the users (US$)					Total water fee to be collected (US$)					Revenue collection performance (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	11966.7	6547.6	5500.6	NA	NA	23933.3	13392.9	11703.4	NA	NA	50.00	48.9	47.0
Beyler	NA	NA	26892.0	14636.9	43340.4	NA	NA	51666.7	50297.6	90850.0	NA	NA	52.05	29.1	47.7
Germeçtepe-Kırcalar	39578.9	26110.4	50760.0	64232.7	71844.9	110734.4	68711.7	104875.3	111066.7	146062.9	35.7	38.0	48.40	57.8	49.2
Hasköy	NA	44607.8	55713.3	17857.1	56751.1	NA	62559.7	100000.0	73797.6	86105.6	NA	71.3	55.71	24.2	65.9
Karaçomak	24375.0	23647.4	42562.0	28279.8	36713.5	79492.2	66964.3	85124.7	70699.4	100226.4	30.7	35.3	50.00	40.0	36.6
Karaderer	NA	NA	NA	91611.3	119551.1	NA	NA	NA	113166.7	222506.7	NA	NA	NA	81.0	53.7

NA: Not available.

management cost for all schemes.

The highest labor cost were determined for Beyler irrigation scheme with 36184 USD per person in 2011 and the lowest value with 1032 USD for Asar scheme in 2011 (Table 9). Labor cost steadily declined from year 2008 to 2012 for all irrigation schemes.

The highest revenue collection performance was estimated for Karadere scheme with the percentage value of 81 in 2011 (Table 10). The lowest figure for the same variable was calculated for Hasköy scheme with a value of 24% in 2011. Revenue collection performance values are mostly located around 50% in the irrigation schemes between 2008 and 2012 (Table 10). Similar results were reported by Şener et al. (2007) but these revenue collection performances are not sufficient when compared with the study of Yercan et al. (2009).

The highest and the lowest values of service area per personnel were found in Beyler scheme with 5178 ha person^{-1} in 2011 and Germeçtepe-Kırcalar irrigation scheme with 200 ha person^{-1} in 2012, respectively (Table 11). Yercan et al. (2009)

Table 11. Service area controlled per personnel in the selected WUAs.

Irrigation schemes	Total number of personnel employed in operation and maintenance					Irrigation area (ha)					Service area per personnel (ha person^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	2	3	2	NA	NA	1010	1010	1010	NA	NA	505.0	336.7	505.0
Beyler	NA	NA	24	1	3	NA	NA	5178	5178	5178	NA	NA	215.8	5178.0	1726.0
Germeçtepe-Kırcalar	9	9	10	10	11	2100	2100	2100	2196	2196	233.3	233.3	210.0	219.6	199.6
Hasköy	NA	9	9	9	10	NA	2580	2580	2580	2580	NA	286.7	286.7	286.7	258.0
Karaçomak	7	7	7	8	7	1670	1670	1670	1670	1670	238.6	238.6	238.6	208.8	238.6
Karaderer	NA	NA	NA	10	14	NA	NA	NA	5810	5810	NA	NA	NA	581.0	415.0

NA: Not available.

Table 12. Output per unit command area for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Irrigation area (ha)	Output per unit command area (US$ ha^{-1})
Asar	697846.8	1010.0	690.9
Beyler	2308004.8	5178.0	445.7
Germeçtepe-Kırcalar	2434391.9	2196.0	1108.6
Hasköy	5788944.4	2580.0	2243.8
Karaçomak	3097159.6	1670.0	1854.6
Karaderer	22980052.2	5810.0	3955.3

stressed that the number of labor for an irrigation scheme should be less than 3 per 1000 ha of irrigated land for an effective management. Therefore, the analysis of the current data implies that more than enough people are employed for most of the schemes (Table 11). This situation can be partly attributed to the extensive open channel system to distribute available water supply to the farmers for all irrigation schemes.

The highest and the lowest output per unit of command area were obtained from the Karadere irrigation scheme with US$ 3955 ha^{-1} and for Beyler irrigation scheme with US$ 446 ha^{-1}, respectively (Table 12). In the study of Çakmak et al. (2004), output per unit of command area was between US$ 635 and US$ 2636 ha^{-1}. As similar to these results, the highest output per unit of irrigated area was obtained for Karadere irrigation scheme with US$ 14072 ha $^{-1}$ while the lowest output of that is for Beyler scheme with US$ 3288 ha^{-1} (Table 13). Output per unit of irrigated area was calculated between US$ 87 ha^{-1} and US$ 4678 ha^{-1} in by Çakmak et al. (2002). Concerning the output per unit of water diverted to the network, Karadere irrigation scheme had the highest value with US$ 2.1 m^{-3} while Asar irrigation schemes had the lowest value with US$ 0.2 m^{-3} (Table 14). Merdun (2004) obtained these values between US$ 0.04 m^{-3} and US$ 0.56 m^{-3} for his study. The highest outputs per unit of consumed irrigation water was obtained for the Karadere irrigation scheme with US$ 5.2 m^{-3}, and the lowest for Beyler scheme with US$ 1.2 m^{-3} as similar to results of Tables 12 and 13. Values for Molden et al. (1998) study were between US$ 0.05 m^{-3} and US$ 0.62 m^{-3}. The differences in

Table 13. Output per unit irrigated area for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Irrigated area (ha)	Output per unit irrigated area (US$ ha^{-1})
Asar	697846.8	67.0	10415.6
Beyler	2308004.8	702.0	3287.8
Germeçtepe-Kırcalar	2434391.9	663.0	3671.8
Hasköy	5788944.4	439.0	13186.7
Karaçomak	3097159.6	501.0	6182.0
Karaderer	22980052.2	1633.0	14072.3

Table 14. Output per unit of irrigation supply for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Total amount of water diverted to network (m^3)	Output per unit of water diverted (US$ m^{-3})
Asar	697846.8	2842000.0	0.2
Beyler	2308004.8	5113000.0	0.5
Germeçtepe-Kırcalar	2434391.9	6873000.0	0.4
Hasköy	5788944.4	4575000.0	1.3
Karaçomak	3097159.6	6716000.0	0.5
Karaderer	22980052.2	10755000.0	2.1

Table 15. Output per unit water consumed for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Crop water requirement (m^3)	Output per unit water consumed (US$ m^{-3})
Asar	697846.8	222000.0	3.1
Beyler	2308004.8	1857000.0	1.2
Germeçtepe-Kırcalar	2434391.9	1792000.0	1.4
Hasköy	5788944.4	1186000.0	4.9
Karaçomak	3097159.6	1379000.0	2.2
Karaderer	22980052.2	4419000.0	5.2

productivity performance compared with the previous studies were due to the higher total agricultural production in this study.

Conclusion

Results of this study showed that high amount of water was diverted to the most of the irrigation schemes. However, the highest amount of the water from the source was used by Asar scheme. On the other hand, productivity analysis showed the promising performance thanks to higher yield and the type of crop quality for all of the schemes. Regarding financial analysis, total revenue collected from water users were not sufficient to meet the maintenance operational management costs, however, it was generally sufficient to meet maintenance cost for all irrigation schemes. Moreover, operational costs per unit irrigation area and cost per personnel were found higher in the beginning of studied years, than they exhibited a decline up to 2012. Additionally, revenue collection performance results were almost 50% which is not sufficient. Regarding the service area per personnel, it can be explained that all irrigation services have excess employed personnel thanks to distribution network of all irrigation schemes. In conclusion, productivity analysis performed promising but water delivery and financial performance need further studies.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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REFERENCES

Akkuzu E, Ünal HB, Karataş BS, Avcı M, Aşık S (2007). General irrigation planning performance of water user associations in the Gediz Basin in Turkey. J. Irrig. Drain. Eng. 133:17-26.

Anonymous (2013). Records of Meteorology Situation. General Directorate of Meteorology, Ankara, Turkey.

Beyribey M (1997). Evaluation of irrigation system performance in state irrigation schemes. Ankara University, Agriculture Faculty, Publication No. 1480, Scientific Research Exam., Ankara, pp. 88.

Çakmak B (2002). Assessment of Irrigation System Performance in Irrigation Associations, Kızılırmak Basin. KSU J. Sci. Eng. 5:130-141.

Çakmak B, Aküzüm T (2006). Water management in agriculture in Turkey: Problems and Solutions. Chamber of Civil Engineers in Turkey-Water Policy Conference, 2:349-359.

Çakmak B, Beyribey M, Yıldırım YE, Kodal S (2004). Benchmarking Performance of Irrigation Schemes: A Case Study from Turkey. Irrigat Drain. 53:155-164.

Cakmak B, Kibaroğlu A, Kendirli B, Gökalp AZ (2010). Assessment of the Irrıgatıon Performance of Transferred Schemes in Turkey: A Case Study Analysıs. Irrigat. Drain. 59:138-149.

Değirmenci H, Büyükcangaz H, Kuşçu H (2003). Assessment of Irrigation with Comparative Indicators in the Southeastern Anatolia Project. Turk. J. Agr. For. 27:293-303.

Dorsan F, Anaç S, Akçay S (2004). Performance Evaluation of Transferred Irrigation Schemes of Lower Gediz Basin. J. Appl. Sci. 4:231-234.

Kukul YS, Akçay S, Anaç S, Yeşilırmak E (2008). Temporal irrigation performance assessment in Turkey: Menemen case study. Agr. Water. Manag. 95:1090-1098.

Malano H, Burton M (2001). Guidelines for Benchmarking Performance in the Irrigation and Drainage Sector. International Programme for Technology and Research in Irrigation and Drainage (IPTRID), FAO: Rome, Italy; 44 P.

Mengü GP, Akkuzu E (2010). Impact of Irrigation Management Transfer on Land and Water Productivity and Water Supply in the Gediz Basin, Turkey. J. Irrig. Drain Eng. 136:300-308.

Merdun H (2004). Comparison of Irrigation Performance Based on The Basin, Crop Pattern, and Scheme Sizes Using External Indicators. Turk. J. Agric For.28:321-331.

Molden DJ, Sakthivadiel R, Perry CJ, Fraiture C (1998). Indicators for Comparing Performance of Irrigated Agriculture System. IWMI Research Report 20, Colombo Sri Lanka.

Molden DJ, Sakthivadivel R (1999). Water accounting to assess use and productivity of water. Water Resour. Dev. 15: 55-71.

Nalbantoğlu G, Çakmak B (2007). Benchmarking of Irrigation Performance in Akıncı Irrigation District. Journal of Agricultural Sciences, Ankara University Faculty of Agriculture, 13:213-223.

Özturk A (2004). Formation of salinity and sodium. The effect of plant and soil. Management of Salinity at Irrigation Area. Symposium papers, 20-21 May, Ankara, pp.1-16.

Sakthivadivel R, De Fraiture C, Molden DJ, Perry C, Kloezen W (1999). Indicators for land and water productivity in irrigated agriculture. Water Resour. Dev. 15:161-179.

Sayın B, Karaman S, Yılmaz I, Celikyurt MA (2013). Assessment of the performance of participatory irrigation management in Antalya, Turkey. Water Pol. 15:269-280.

Şener M (2012). Assessment of irrigation management transfer: A case study of Meric-Ergene Basin in Turkey. J. Food Agric. Environ. 10:1060-1064.

Şener M, Yüksel AN, Konukçu F (2007). Evaluation of Hayrabolu Irrigation Scheme in Turkey Using Comparetive Performance Indicators. J. Tekirdağ Facul. Agric. 4:43-54.

Uçar Y, Şenyigit U, Kadayıfcı A, Tüylü GI (2010). Evaluation of water use efficiency at parcel and scheme levels: A case study of Sarkikaraagac irrigation scheme in Turkey. J. Food Agr. Environ. 8:1046-1053.

Yercan M, Atiş E, Salali HE (2009). Assessing irrigation performance in the Gediz River Basin of Turkey: Water User Associations Versus Cooperatives. Irrigat. Sci. 27:263-270.

Yercan M, Dorsan F, Ul MA (2004). Comparative analysis of performance criteria in irrigation schemes: a case study of the Gediz River Basin in Turkey. Agric. Water Manag. 66:259-266.

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Scientific Research and Essays

Full Length Research Paper

Effects of physiological status and seasonal variation on plasma mineral profile of sheep in Kashmir valley

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Evaluating mineral profile of sheep, belonging to different physiological states and in different seasons, is an important indicator of their nutritional and health status. This is important to prevent health disorders which lead to production and reproductive disturbances. A total of 167 blood samples were collected in four different seasons of the year from sheep having varied physiological demands in Shuhama Alusteng area of Kashmir valley. The plasma macro-minerals such as Ca, P_i and Mg were measured using standard kits; while as micro-minerals like Cu, Zn and Fe were estimated using atomic absorption spectrometry. The concentration of Ca was below the critical level during pregnant and lactating periods, and round about the critical level throughout the year. The Mg values were just above the critical concentration in all categories of sheep throughout the year. The concentrations of Cu and Zn were above the critical levels in all categories of sheep especially during the winter season. P_i and Fe levels were adequate in all throughout the year. In addition, a good percentage of samples were deficient in one or the other mineral round the year. The results suggest that sheep in the study area should be supplemented with Ca and Mg round the year; Cu and Zn during spring, summer and autumn seasons. Also, the influence of local agro-geo-climatic conditions plus mineral interactions involving greater sample size must be studied prior to attempting the formulation of area specific mineral supplement(s). Further, the dosage should be recommended as per the physiological need of an animal.

Key words: Sheep, physiological status, seasonal variation, minerals, Kashmir valley.

INTRODUCTION

Livestock sector in Asia forms an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing incomes, offering employment opportunities, and finally being a dependable "bank on hooves" in times of need (Ben Salem and Smith, 2008). Jammu and Kashmir (India) is a hilly state with total area of 2,22,236 km^2 that sprawls over the western Himalaya and Karakorum mountains between 32.17° N and 36.58° North latitude and 73.26° E and 83.30° East longitude. The state is divided into three agro-climatic zones: Cold arid desert areas of Ladakh, temperate Kashmir valley and the humid sub-tropical region of Jammu. Each has its own specific geo-climatic condition which reflects the diverse profile of livestock species (Wani and Wani 2010).

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Table 1. Total number of plasma (Sheep) samples collected from the study area.

Area	Season	Lambs/Weaners	Dry	Pregnant	Lactating	Rams	Total
Shuhama Alusteng	Winter	13	7	16	15	10	**61**
	Spring	6	7	6	10	7	**36**
	Summer	8	6	Nil	16	6	**36**
	Autumn	6	6	6	10	6	**34**
	Total	**33**	**26**	**28**	**51**	**29**	**167**

Conducive agro-climatic conditions, rich alpine pastures and other natural endowments provide enormous scope and potential for sheep rearing in the state. Free foraging of small ruminants on alpine pastures, sub-alpines and waste lands for 7 to 8 months on semi-migratory mode of rearing and round the year on migratory mode optimize the input costs. In J&K, 75% population is rural with agriculture as the main stay and livestock-rearing as the subsidiary one. As per 18th Livestock Census of 2007, the sheep population in J&K is about 3.69 million (70% crossbred) out of the total 10.99 million livestock strength. The agriculture and allied sectors contribute about 38% to the state GDP of which 11% is contributed by livestock sector (DES, 2007). In Kashmir valley, sheep farming is admittedly a profitable venture as it is capital oriented not labour intensive and forms an integral component of food production and livelihood system of most of the under-privileged communities and agro-pastoral farmers.

Minerals have been recognized as potent nutrients and their deficiency/imbalance exerts a significant effect on health and productivity of livestock (Kincaid, 1999; Aregheore et al., 2007; Gonul et al., 2009). Suboptimal mineral deficiency that affects growth and production is more serious than the manifested mineral deficiency showing clinical signs that can be corrected (Underwood, 1977). Levels of requirements as well as thresholds of deficiency and toxicity vary with age, sex, production level, activity level, species and genetic strain of the animal. Animal age can affect mineral requirement through changes in efficiency of absorption. The pre-ruminant animal absorbs most minerals more efficiently than the older animal (Standing Committee on Agriculture, 1990). Animals most susceptible to trace element deficiencies are young growing animals and animals during their first pregnancy and lactation (Khan et al., 2003). Gender of animal affects susceptibility to mineral disorders probably through differences in growth rate and physiological function (Shallow et al., 1989).

Mineral inadequacies in livestock are often seasonal, resulting from increased demands of pregnancy, lactation or rapid growth coinciding with reduced mineral content or availability in the pasture (Tashi et al., 2005). The mineral content in forages is influenced by several factors such as soil, plant species, and stage of maturity, yield, pasture management and climate (Poland et al., 2001). The physiological response of animals to environmental stress (heat/cold) exerts a profound effect on serum biochemical parameters (Nazifi et al., 1999).

Assessment of mineral status of grazing animals has been considered an important strategy to increase animal productivity, especially in mineral deficient areas (Khan et al., 2003). In Kashmir, sheep are mainly maintained on grazing with little or no mineral supplementation. Hence, the study was undertaken to evaluate the plasma mineral content of sheep in Shuhama Alusteng area so as to devise the supplementation strategy for ensuring optimum production performance and prevention of health disorders.

MATERIALS AND METHODS

The study area in district Ganderbal is located at 34° 12' N 74° 46'E with an average elevation of 1,619 m (5,312 ft) and is characterized by sub-humid temperate climate with mean annual rainfall of 744 mm and mean annual temperature of 13.4°C.

Blood samples

Blood samples from sheep belonging to different physiological states (lambs/weaners aged 3 to 6 months; dry, pregnant, lactating ewes, and rams aged 2 to 5 years; majority of animals belonging to non-descript and Corriedale breed) and in different seasons of the year (spring/summer/autumn/winter as shown in Table 1) were collected by jugular venipuncture in heparinised vials, centrifuged at 3000 rpm for 10 min to harvest the plasma which was then transferred to sterile, acid-washed vials, labelled and stored at -40°C until transport to laboratory where the samples were stored at -20°C for further analysis.

Estimation of plasma minerals

Calcium

Plasma calcium was estimated by O-Cresolphthalein Complexone (OCPC) end point assay (Span Diagnostics Ltd. India).20 µl of plasma samples were taken in labelled test tubes followed by 1000 µl of working Ca reagent. Standard was prepared in triplicate with 20 µl of Ca standard in test tubes mixed with 1000 µl of working Ca reagent. Test tube containing 1000 µl working Ca reagent was used as reagent blank. After mixing the reagents, test tubes were incubated at 37°C or room temperature (15 to 30°C) for 5 min. Analyzer programmed (578 nm) as per assay conditions and absorbance of standards followed by plasma samples was taken against blank.

Calculations:

Plasma Ca (mg/dl) = Absorbance of Test/Absorbance of Standard × 10

Phosphorus

Plasma inorganic phosphorus (Pi) was estimated by UV Molybdate, end point assay (Span Diagnostics Ltd. India).10 µl of plasma samples were taken in labelled test tubes to which 1000 µl of reagent 1 was added and mixed well. Test tubes containing 10 µl of Pi standard and 1000 µl of reagent 1 were taken in triplicate as standard. Reagent blank was prepared by taking 1000 µl of reagent 1 in the test tube. All test tubes containing test samples, standards and blank were mixed properly by shaking and incubated at 37C for 5 min. Analyzer was programmed as per assay parameters (340 nm) and blanked with reagent blank. The absorbance of the standard and plasma samples was taken against blank.

Calculations:

Plasma P_i (mg/dl) = Absorbance of Test/Absorbance of Standard × 5

Magnesium

Plasma Mg was estimated by Calmagite method (Crest Biosystems, India).To labelled test tubes, 0.01 ml of plasma samples were added followed by 0.5 ml of buffer reagent (L_1), and 0.5 ml of colour reagent (L_2). Standard was prepared in triplicate which contained 0.5 ml of L_1 reagent, 0.5 ml of L_2 reagent and 0.01 ml of Mg standard. Test tube containing L_1 and L_2 reagents (0.5 ml each) plus 0.01 ml distilled water was used as reagent blank. The contents in test tubes were mixed well by shaking and incubated at 25°C for 5 min. Absorbance of standard and the samples was recorded against blank at 510 nm.

Calculations:

Mg (mEq/L) = Absorbance of Test/Absorbance of Standard × 2 (Note: 1 mEq/L = 0.5 mmol/L= 2.44 mg/dl)

Digestion of plasma samples

Plasma samples were digested as per the standard procedure (Kolmer et al., 1951). To 3 ml of sample in digestion tubes, an equal volume of concentrated HNO_3 was added and mixed well. The tubes were kept for overnight at room temperature followed by low heat (70 to 80°C) digestion until the volume of the samples reduced to 1 ml. To this, 3 ml of double acid mixture (HNO_3 and $HClO_4$ in 3:1 ratio) was added and low heat digestion continued until the digested samples became watery clear and emitted white fumes. As per need, the addition of 3 ml double acid mixture followed by low heat digestion was repeated couple of times. Heating was continued until the volume of the samples got reduced to ~0.5 ml. Final volume of the filtrate was made 10 ml with triple distilled de-ionized water after warming the solution. During digestion of plasma samples simultaneous digestion of reagent blank was also undertaken and final volume of 10 ml stored to have the blank.

Trace mineral estimation

Atomic Absorption Spectrophotometry (AAS) is considered one of the precise techniques for estimation of trace minerals in biological materials. AAS (Model No ECIL 4141) manufactured by Electronic Corporation of India (ECIL), Hyderabad was used in the present study. It uses a double beam with a wave length range of 190 to 900 nm. Separate hollow UV lamps for each mineral were used. Air/acetylene flame was used as fuel. At least three standards of known concentrations were used for calibration and then the unknown test samples were analyzed. After sample analysis, sufficient distilled water flush was done for at least 10 min. Sample analysis was done by attached computer and concentration of mineral samples was expressed in parts per million (ppm).

Statistical analysis

Data collected during the study were analyzed for mean, standard error and analysis of variance (ANOVA) by using SPSS software (version 16).

RESULTS AND DISCUSSION

For maintenance of normal health and sustained efficient production of livestock, it is necessary to ensure adequate dietary intake of essential nutrients. Intensification of production requires full coverage and appropriate balancing of mineral elements (Hosnedlava et al., 2007). In sheep, nutrients quality and quantity directly affect highly demanding reproductive functions such as expression of estrus, embryo implantation and reduction in spermatogenesis, and indirectly affect overall animal health (Vázquez-Armijo et al., 2011). Additionally, kilograms of offspring weaned per female exposed may be affected by both trace mineral supplementation and source (Ahola et al., 2004). Mineral deficiencies that affect livestock at pasture in most regions of the world include those of macro- and micro- minerals (Khan et al., 2005). Excessive intake of minerals can also have an adverse effect on animal health. There are a number of methods to establish the existence or likely existence of specific mineral deficiency/imbalance for grazing livestock, in which determination of concentrations and proportions of minerals in dietary components along with clinical, pathological and biochemical examination of animals and appropriate tissues and fluids are commonly used for diagnosis of mineral status (McDowell, 1992). Signs of mineral disorders are often non specific and in cases of marginal deficiencies may go unnoticed by the stock owners. The interpretation of such signs is also difficult if more than one mineral is deficient or the deficiency is associated with disorders like increased burdens of gastrointestinal parasites, especially when trace element deficiencies coexist as they increase the susceptibility of animal to diseases (Suttle and Jones, 1989).

The overall plasma mineral concentration in sheep belonging to different physiological states and in different seasons is presented in (Tables 2 and 3).

Effect of physiological status on plasma minerals

In sheep, significantly lower and below the critical limit

Table 2. Effect of physiological status and seasonal variation on plasma minerals in sheep.

Parameter	Physiological Status	Seasons									
		Winter		*Spring*		*Summer*		*Autumn*		Overall	
		n	Mean±S. E	n	Mean±S. E	n	Mean±S. E	n	Mean±S. E	n	Mean±S. E
Calcium (mg/dl)	Lambs/weaners	13	9.29±0.50	6	8.99±0.37	8	$9.45±0.35^{B}$	6	$9.24±0.19^{AB}$	33	$9.26±0.22^{B}$
	Dry	7	9.15±0.22	7	8.90±0.44	6	$9.22±0.60^{B}$	6	$9.16±0.55^{AB}$	26	$9.10±0.22^{AB}$
	Pregnant	16	8.25±0.37	6	8.72±0.39		ND	6	$8.74±0.25^{A}$	28	$8.45±0.23^{A}$
	Lactating	15	$8.12±0.25^{a}$	10	$9.14±0.35^{b}$	16	$7.93±0.33^{aA}$	10	$9.13±0.32^{bAB}$	51	$8.46±0.17^{A}$
	Rams	10	$8.29±0.41^{a}$	7	$9.86±0.41^{b}$	6	$10.18±0.39^{bB}$	6	$10.25±0.45^{bB}$	29	$9.46±0.26^{B}$
	Overall	**61**	$8.55±0.18^{a}$	36	$9.14±0.18^{ab}$	36	$8.85±0.25^{ab}$	34	$9.28±0.18^{b}$	167	8.89±0.10
Phosphorus (mg/dl)	Lambs/weaners	13	$7.11±0.51^{bBC}$	6	$6.61±0.54^{bC}$	8	$6.89±0.54^{bB}$	6	$5.16±0.48^{aAB}$	33	$6.61±0.29^{B}$
	Dry	7	$6.27±0.34^{bABC}$	7	$3.96±0.29^{aA}$	6	$5.97±0.40^{bAB}$	6	$5.52±0.50^{bAB}$	26	$5.41±0.26^{A}$
	Pregnant	16	$7.33±0.51^{C}$	6	$5.97±0.57^{BC}$		ND	6	$6.31±0.59^{B}$	28	$6.82±0.35^{B}$
	Lactating	15	$5.52±0.46^{bAB}$	10	$3.67±0.56^{aA}$	16	$4.99±0.34^{abA}$	10	$4.77±0.40^{abAB}$	51	$4.84±0.23^{A}$
	Rams	10	$5.29±0.67^{A}$	7	$4.64±0.40^{AB}$	6	$5.40±0.68^{AB}$	6	$4.20±0.88^{A}$	29	$4.93±0.33^{A}$
	Overall	**61**	$6.38±0.26^{c}$	36	$4.79±0.29^{a}$	36	$5.64±0.26^{bc}$	34	$5.14±0.26^{ab}$	167	5.63±0.14
Magnesium (mg/dl)	Lambs/weaners	13	$1.63±0.10^{a}$	6	$1.48±0.16^{a}$	8	$1.82±0.16^{a}$	6	$2.15±0.19^{b}$	33	1.74±0.08
	Dry	7	1.76±0.21	7	1.79±0.17	6	1.94±0.23	6	2.20±0.34	26	1.91±0.12
	Pregnant	16	1.77±0.08	6	1.69±0.15		ND	6	1.92± 0.30	28	1.79±0.08
	Lactating	15	$1.66±0.08^{ab}$	10	$1.52±0.10^{a}$	16	$1.85±0.15^{ab}$	10	$2.06±0.19^{b}$	51	1.77±0.07
	Rams	10	1.75±0.11	7	1.91±0.16	6	2.01±0.40	6	2.37±0.37	29	1.97±0.12
	Overall	**61**	$1.71±0.05^{a}$	36	$1.67±0.07^{a}$	36	$1.88±0.10^{a}$	34	$2.13±0.12^{b}$	167	1.82±0.04
Copper (ppm)	Lambs/weaners	13	$1.39±0.15^{b}$	6	$0.83±0.16^{a}$	8	$0.78±0.19^{a}$	6	$0.75±0.09^{a}$	33	1.02±0.09
	Dry	7	$1.33±0.26^{b}$	7	$1.00±0.11^{ab}$	6	$0.68±0.06^{a}$	6	$0.76±0.07^{a}$	26	0.96±0.09
	Pregnant	16	1.28±0.15	6	0.72±0.13		ND	6	1.03 ± 0.29	28	1.10±0.11
	Lactating	15	$1.38±0.18^{b}$	10	$0.86±0.08^{a}$	16	$0.68±0.05^{a}$	10	$0.81±0.06^{a}$	51	0.94±0.07
	Rams	10	0.99±0.26	7	0.67±0.04	6	0.96±0.22	6	0.88±0.22	29	0.88±0.11
	Overall	**61**	$1.28±0.08^{b}$	36	$0.82±0.05^{a}$	36	$0.74±0.06^{a}$	34	$0.84±0.07^{a}$	167	0.98±0.04
Zinc (ppm)	Lambs/weaners	13	0.94±0.14	6	0.81±0.18	8	0.71±0.12	6	0.84±0.14	33	0.84±0.07
	Dry	7	1.26±0.19	7	0.65±0.13	6	0.73±0.10	6	0.93±0.32	26	0.90±0.10
	Pregnant	16	1.22±0.13	6	0.86±0.16		ND	6	0.83±0.17	28	1.06±0.09
	Lactating	15	$1.17±0.17^{b}$	10	$0.71±0.13^{a}$	16	$0.69±0.07^{a}$	10	$0.69±0.09^{a}$	51	0.83±0.07
	Rams	10	$1.42±0.20^{b}$	7	$0.66±0.07^{a}$	6	$0.82±0.11^{a}$	6	$0.69±0.09^{a}$	29	0.96±0.10
	Overall	**61**	$1.19±0.07^{b}$	36	$0.73±0.06^{a}$	36	$0.73±0.05^{a}$	34	$0.78±0.07^{a}$	167	0.91±0.04
Iron (ppm)	Lambs/weaners	13	$3.76±0.67^{b}$	6	$2.02±0.32^{ab}$	8	$1.53±0.16^{a}$	6	$2.66±0.44^{ab}$	33	$2.70±0.32^{AB}$
	Dry	7	3.53±1.00	7	2.48±0.71	6	1.76±0.28	6	2.30±0.55	26	$2.55±0.36^{A}$
	Pregnant	16	3.93±0.36	6	2.53±0.58		ND	6	3.49±0.50	28	$3.54±0.28^{B}$
	Lactating	15	$3.80±0.38^{b}$	10	$2.27±0.41^{a}$	16	$1.83±0.25^{a}$	10	$3.65±0.42^{a}$	51	$2.85±0.21^{AB}$
	Rams	10	$4.86±0.75^{b}$	7	$2.20±0.44^{a}$	6	$2.30±0.49^{a}$	6	$3.93±0.39^{ab}$	29	3.49±0.37
	Overall	**61**	$3.97±0.25^{c}$	36	$2.30±0.22^{a}$	36	$1.83±0.15^{a}$	34	$3.26±0.22^{b}$	167	3.00±0.13

Means bearing different uppercase superscripts across the columns for each parameter differ significantly (P<0.05); Means bearing different lower case superscripts across the rows differ significantly (P<0.05); ND=No Data (No sample available).

Table 3. Percent samples (sheep plasma) deficient in minerals.

Mineral	Critical concentration* (mg/dl)	Season	Physiological status					
			Lambs/weaners	*Dry*	*Pregnant*	*Lactating*	*Rams*	Overall
Calcium	9.00	Winter	6/13=46.2%	3/7=42.9%	11/16=68.8%	12/15=80%	6/10=60%	**38/61=62.29%**
		Spring	2/6=33.3%	3/7=42.9%	4/6=66.6%	3/10=30%	1/7=14.3%	**13/36=36.11%**
		Summer	3/8=37.5%	3/6=50.0%	ND	12/16=75%	1/6=16.7%	**19/36=52.77%**
		Autumn	1/6=16.67%	3/6=50.0%	4/6=66.6%	5/10=50%	1/6=16.7%	**14/34=41.18%**
		Overall	**12/33=36.36%**	**12/26=46.15%**	**19/28=67.86%**	**32/51=62.75%**	**9/29=31.03%**	
Phosphorus	4.00	Winter	1/13=7.7%	0/7=0	3/16=18.8%	2/15=13.3%	3/10=30%	**9/61=14.75%**
		Spring	0/6=0	3/6=50%	0/6=0	7/10=70%	2/7=28.6%	**12/36=33.33%**
		Summer	0/8=0	0/6=0	ND	4/16=25%	1/6=16.7%	**5/36=13.89%**
		Autumn	1/6=16.7%	1/6=16.7%	0/6=0	3/10=30%	4/6=66.7%	**9/34=26.47%**
		Overall	**2/33=6.06%**	**4/26=15.38%**	**3/28=10.71%**	**14/51=27.45%**	**10/29=34.48%**	
Magnesium	1.50	Winter	5/13=38.5%	2/7=28.6%	3/16=18.8%	4/15=26.6%	3/10=30%	**17/61=27.87%**
		Spring	4/6=66.7%	1/7=14.3%	2/6=33.3%	4/10=40%	2/7=21.6%	**13/36=36.11%**
		Summer	2/8=25%	1/6=16.7%	ND	2/16=12.5%	1/6=16.7%	**6/36=16.67%**
		Autumn	1/6=16.7%	2/6=33.3%	2/6=33.3%	1/10=10%	1/6=16.7%	**7/34=20.6%**
		Overall	**12/33=36.36%**	**6/26=23.08%**	**7/28=25.0%**	**11/51=21.57%**	**7/29=24.14%**	
Copper	0.60	Winter	1/13=7.7%	1/7=14.3%	0/16=0	3/15=21.6%	5/10=50%	**10/61=16.4%**
		Spring	2/6=33.3%	0/7=0	2/6=33.3%	2/10=20%	2/7=28.6%	**8/36=22.2%**
		Summer	3/8=37.5%	2/6=33.3%	ND	4/16=25%	1/6=16.7%	**10/36=27.8%**
		Autumn	2/6=33.3%	1/6=16.7%	2/6=33.3%	1/10=10%	2/6=33.3	**8/34=23.5%**
		Overall	**8/33=24.24%**	**4/26=15.38%**	**4/28=14.29%**	**10/51=19.61%**	**10/29=34.48%**	
Zinc	0.60	Winter	3/13=23%	1/7=14.3%	1/16=6.3%	1/15=6.7%	0/10=0	**6/61=9.8%**
		Spring	2/7=28.6%	2/7=28.6%	2/6=33.3%	6/10=60%	2/7=28.6%	**14/36=38.9%**
		Summer	3/8=37.5%	1/6=16.6%	ND	4/16=25%	1/6=16.6%	**9/36=25%**
		Autumn	1/6=16.7%	2/6=33.3%	2/6=33.3%	4/10=40%	2/6=33.3%	**11/34=32.4%**
		Overall	**9/33=27.3%**	**6/26=23.1%**	**5/28=17.9%**	**15/51=29.4%**	**5/29=17.2%**	
Iron	1.20	Winter	0/13=0	0/7=0	0/16=0	0/15=0	0/10=0	**0/61=0**
		Spring	1/6=16.7%	1/7=14.3%	1/6=16.7%	2/10=20%	1/7=14.3%	**6/36=16.7%**
		Summer	1/8=12.5%	1/6=16.7%	ND	2/16=12.6%	1/6=16.7%	**5/36=13.9%**
		Autumn	0/6=0	1/6=16.7%	0/6=0	0/10=0	0/6=0	**1/34=2.94%**
		Overall	**2/33=6.1%**	**3/26=11.5%**	**1/28=3.6%**	**4/51=7.8%**	**2/29=6.9%**	

*Radostitis et al. (2000).

Ca concentration was observed in pregnant and lactating ewes as compared to rams, lambs/weaners and dry ewes which could be attributed to dietary imbalances of Ca and P, higher requirements due to pregnancy owing to marked increase in the needs of fetal skeleton for mineralization, increased endogenous Ca loss with the advance of pregnancy, dietary interaction with other minerals (Maynard et al., 1979) and negative Ca balance owing to excessive secretion of Ca through milk (Asif et al., 1996). The outflow of Ca into milk at the onset of lactation may be accompanied by a reduction in the plasma Ca pool (Remberg et al., 1970). The higher concentration of Ca in young growing animals could be due to more efficient absorption of Ca in young than that of older animals (Ricks, 1996). Also, in growing animals, net retention of Ca occurs in the body, while in adults the amount ingested equals that lost if metabolic requirement is met (Church and Pond, 1988). Moreover, absorption efficiency is well known to fall with age which partly relates to the decline in vitamin D stores (Robert, 1989). The percent samples deficient in Ca were in the order of pregnant>lactating>dry>lambs/weaners>rams. The study revealed adequate plasma P_i irrespective of the physiological status and/or season of the year with significantly lower concentration in lactating ewes compared to lambs/weaners. The marked increase in P_i secretion in milk may be the reason (Braithwaite, 1983). Serum phosphate has been seen higher in young animals because the growth hormone increases renal phosphate resorption (Kaneko et al., 1997). The percent samples deficient in P_i were in the order rams>lactating>dry> pregnant>lambs/weaners. The Mg concentration observed was just above the critical level especially in lambs/weaners, pregnant and lactating ewes. These findings might be attributed to hemodilution that occurs during late pregnancy and lactation, increased physiological demands for Mg in such category of animals, and the more rapid uptake of Mg by young than adult animals (Ahmed et al., 2000). Furthermore, exchange of radio Mg in bone has been recorded 5 to 10 times greater in young than old animals (Breibart et al., 1960) owing to more water content in former than latter (Fontenot et al., 1989). The percent samples deficient in Mg were in the order of lambs/weaners> pregnant>rams >dry>lactating. During gestation, both the mother and fetus are very susceptible to dietary mineral imbalances owing to time of rapid growth and cell differentiation (Ghany-Hefnawy et al., 2007). Lambs born to mineral deficient ewes have lower birth weight, poor energy utilization, insufficient quantity and quality of colostrum, slower suckling reflex, greater risk of hypothermia, and increased risk for diseases such as white muscle disease, enlarged thyroid gland, muscular in co-ordination and bone abnormalities.

The Cu concentration observed was adequate in all categories of sheep though non-significantly higher in pregnant ewes in which it may be attributed to higher progesterone level and/or to the increased fetal demands and utilization of maternal Cu for development of fetal nervous system (Elnageeb and Abdelatif, 2010). Moreover, pregnancy is usually associated with an increase in plasma Cu levels in the form of ceruloplasmin due to increase in oestrogen levels during late pregnancy (Howell et al., 1968). Low Cu content in sheep rations inhibits embryo implantation, causes embryo loss and fetal death (Hidiroglou, 1979). In sheep, postnatal lordosis, detected as muscle weakness and ataxia, is also caused by Cu deficiency during gestation (Ashworth and Antipatis, 2001). Du Plessis et al. (1999) observed a suppressed estrous behaviour in ewes due to induced secondary Cu deficiency that might be attributed to altered production and/or expression of hormones, such as estrogens and luteinizing hormone (LH) and follicle-stimulating hormone (FSH). The percent samples deficient in Cu were in the order of rams>lambs/weaners>lactating >dry>pregnant. Zn concentration besides being adequate in all categories was non-significantly higher in pregnant ewes, and the percent samples deficient in Zn were in the order of lactating>lambs/weaners>dry>pregnant>rams. These observations could be due to increased demands for Zn towards the end of pregnancy (Elnageeb and Abdelatif, 2010), increased rate of Zn accumulation in the fetus, and the higher plasma albumin levels in pregnant animals to which Zn is bound primarily (Davis, 1984). Similar findings have been observed by other authors (Williams, 1977). However, decreased serum Zn level during late gestation as a result of hemodilution has been found in desert ewes (Masters and Fels, 1980). Zn deficiency in males affects spermatogenic process as well as primary and secondary sex organ development, and in females it could affect any phase of the reproductive processes- estrus, gestation or lactation (Smith and Akinbamijo, 2000). Zn also plays a key role in maintaining the integrity of epithelia of the reproductive organs, which is necessary for embryo implantation (Robinson et al., 2006), besides, adequate concentrations of Zn in serum and in diets, are vital for uterine involution and tissue repair post-partum, and particularly the return to estrus.The Fe concentration observed was adequate with significantly higher in pregnant ewes. Relatively high Fe concentration from 3rd to 7th month of pregnancy compared to minimum concentration when lactation commenced has been reported (Tainturier et al., 1984). The percent samples deficient in Fe were in the order of dry>lactating>rams>lambs/weaners> pregnant. Yatoo et al. (2013) reported higher prevalence of copper deficiency followed by zinc, cobalt and iron in sheep of few districts of Kashmir.

Effect of seasonal variation on plasma minerals

The Ca concentration observed was round about the critical limit throughout the year, significantly lower in winter as compared to autumn season, and the percent samples deficient in Ca were in the order of winter> summer>autumn>spring. This might be attributed to higher dietary availability of Ca during dry season than wet season plus the higher absorption efficiency in drier months (Khan, 2003). A good percentage of animals were found Ca deficient throughout the year. The P_i concentration observed though adequate round the year was significantly lower in spring and higher in winter season. The percent samples deficient in P_i were in the order of winter>autumn>spring>summer. The Mg concentration was just above the critical level throughout the year but significantly lower in spring, winter and summer as compared to autumn season. The percent samples deficient in Mg were in the order of spring>winter>autumn>summer. This might be due to maximum Mg excretion through faeces in spring/winter than during autumn, and thus less absorption through the gastrointestinal tract in wet seasons than dry season (Khan, 2003). The Cu levels noticed though adequate were significantly higher in winter as compared to rest of the seasons, and the percent samples deficient in Cu were in the order of summer>autumn>spring>winter. These observations are in agreement with the findings of other researchers (Pastrana et al., 1991). The Zn concentrations (adequate) were higher in winter as compared to rest of the seasons with percent samples deficient being in the order of spring>autumn>summer>winter. Higher plasma Zn concentration in winter than summer has been reported (Khan et al., 2008). Throughout the year, the Fe concentration was more than adequate with significantly higher concentration in winter compared to rest of the seasons, with percent samples deficient being in the order of summer > spring > autumn > winter. Similar observations have been recorded by other authors

(Merkel et al., 1990; Rojas et al., 1993). Significantly higher blood Ca and Mg level has been recorded in summer than winter season, with higher Ca concentration in lambs than adults (Pasha et al., 2009). Lower plasma Ca and Mg concentration has been noticed in winter than summer in lactating and non lactating ewes, and in rams as well but the reverse trend has been observed for Cu, Fe and Zn (Khan et al., 2003).

Conclusion

In this study, a significant influence of physiological status and seasonal variation on plasma mineral concentration of sheep was found, hence the dosage of supplement(s), if any, should be recommended as per the physiological need of an animal under existing climatic conditions. The experimental findings also suggest that sheep of this area should be supplemented with Ca and Mg round the year, Cu and Zn during spring, summer and autumn seasons. This study could well set a platform for much detailed and wider scale investigations in future where in larger sample size and mineral interaction in regional soil-fodder-animal system is evaluated which would further confirm these findings and allow the formulation of Kashmir specific mineral supplement(s).

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Abbreviations: Ca, Calcium; **P_i,** Inorganic Phosphorus; **Mg,** Magnesium; **Cu,** Copper; **Zn,** Zinc; **Fe,** Iron; **AAS,** Atomic Absorption Spectrophotometer.

REFERENCES

Ahmed MM, Siham KA, Bari MES (2000). Macromineral profile in the plasma of 185 nubian goats as affected by the physiological state. Small Rumin. Res. 38:249-254.

Ahola JK, Baker DS, Burns PD, Mortimer RG, Enns RM, Whittier JC, Geary TW, Engle TE (2004). Effect of copper, zinc, and manganese supplementation and source on reproduction, mineral status, and performance in grazing beef cattle over two-year period. J. Anim. Sci. 82:2375-2383.

Aregheore EM, Hunter D, Perera D, Mautoatasi MT (2007). The soil-plant-animal phenomena: Serum mineral status of Fuji fantastic sheep grazing Batiki grass (*Ischaemum aristatum* Var. *indicum*) and Pangola grass (*Digitaria decumbens*) in Samoa. J. Anim. Vet. Adv. 6:349-357.

Ashworth CJ, Antipatis C (2001). Micronutrient programming of development throughout gestation. Reprod. 122:527-535.

Asif M, Rahman ZU, Arif M, Haq IU, Javed I (1996). Trace element and electrolyte concentrations in different physiological states of Sahiwal cattle. J. Islam. Acad. Sci. 9(4):125-128.

Ben Salem H, Smith T (2008). Feeding strategies to increase small ruminant production in dry environments. Small Rumin. Res. 77:174-194.

Braithwaite GD (1983). Calcium and Phosphorus requirements of the Ewe during pregnancy and lactation. Br. J. Nutr. 50:711-722.

Breibart S, Lec JS, MeCoord A, Forbco GA (1960). Relation of age to radio magnesium exchange in bone. Proc. Soc. Expt. Biol. Med. 105:361-368.

Church DC, Pond WG (1988). Basic Animal Nutrition and Feeding. 3rd Edition. Published by John Wiley and Sons, New York, NY. pp. 196-199.

Davis A (1984). Coal petrology and petrographic analysis. In: Ward, C.R. (Ed.), Coal Geology and Coal Technology. Blackwell, Oxford pp. 74-112.

DES (2007). Department of economic survey. Annual report. In: Wani, S.A. and Wani, M.H. (2010). Marketing of Milk in Various Agro-climatic Zones of Jammu and Kashmir. Agric. Econ. Res. Rev. 23:83-90.

Du Plessis SS, Van Niekerk FE, Coetzer WA (1999). The effect of dietary molybdenum and sulphate on sexual activity and plasma progesterone concentrations of ewes. Small Rumin. Res. 33:71-76.

Elnageeb MA, Abdelatif AM (2010). The mineral profile in Desert ewes (Ovis aries): Effects of pregnancy, lactation and dietary supplementation. American – Euras. J. Agric. Environ. Sci. 7(1):18-30.

Fontenot JP, Allen VG, Bunce GE, Goff JP (1989). Factors influencing magnesium absorption and metabolism in ruminants. J. Anim. Sci. 67:3445.

Ghany-Hefnawy AE, López-Arellano R, Revilla-Vázquez A, Ramírez-Bribiesca E, Tórtora-Pérez J (2007). The relationship between fetal and maternal selenium concentrations in sheep and goats. Small Rumin. Res. 73:174-180.

Gonul R, Kayar A, Bilal T, Erman ORM, Parkan DVM, Dodurka HT, Gulyasar T, Barutcu B (2009). Comparison of mineral levels in bone and blood serum of cattle in Northwestern Turkey. J. Anim. Vet. Adv. 8:1263-1267.

Hidiroglou M (1979). Trace element deficiencies and fertility in ruminants: A review. J. Dairy Sci. 62:1195-1206.

Hosnedlava B, Travnicek J, Soch M (2007). Current view of the significance of the Zn in the ruminants: A review. Agricultura. Tropica. Et. Subtropica. 40(2):57-64.

Howell JM, Edington N, Ewbank R (1968). Observation on copper and ceruloplasmin levels in the blood of pregnant ewes and lambs. Res. Vet. Sci. 9:160-164.

Kaneko JJ, Harvey JW, Bruss MZ (1997). In: Clinical Biochemistry of Domestic Animals. 5th Edition. Academic press, USA.

Khan ZI (2003). Effect of seasonal variation on the availability of macro- and micro nutrients to animals (sheep and goats) through forage from soil. Ph.D.thesis submitted to University of Agriculture, Faisalabad. p. 286.

Khan ZI, Ahmed K, Ashraf M, Valeem EE, Javed I (2008). A comparative study on mineral status of blood plasma of small ruminants and Pastures in Punjab, Pakistan. Pak. J. Bot. 41:67-72.

Khan ZI, Ashraf M, Ashraf MY, Rahman Z, Hussain A (2003). Mineral status of livestock (Goats and Sheep) based on soil, dietary components and animal tissue fluids in relation to seasonal changes and sampling periods in specific region of Pakistan. J. Anim. Vet. Adv. 2(8):478-495.

Khan ZI, Hussain A, Ashraf M, Valeem EE, Javed I (2005). Evaluation of variation of soil and forage minerals in pasture in a semiarid region of Pakistan. Pak. J. Bot. 37:921-931.

Kincaid RL (1999). Assessment of trace mineral status of ruminants: A review. Proc. Am. Soc. Anim. Sci. pp. 1-10.

Kolmer JA, Spanbling EH, Robinson HW (1951). Approved Laboratory Technique. Appleton Century Crofts, New York.
Masters DG, Fels HE (1980). Effect of Zn supplementation on reproductive performance of grazing Merion ewes. Biol. Trace Elem. Res. 7:89.
Maynard LA, Loosli JK, Hintz HF, Warner RG (1979). Animal Nutrition. 7th Edition. McGraw-Hill Book Co. New York.
McDowell LR (1992). Minerals in Animal and Human Nutrition. Academic Press, NewYork.
Merkel RC, McDowell LR, Popenoe HL, Wilkinson NS (1990). Mineral status comparisons between water buffalo and charolais cattle in Florida. Buffalo J. 1:33-41.
Nazifi S, Gheisari H, Poorabbas H (1999). The influences of thermal stress on serum biochemical parameters of dromedary camels and their correlation with thyroid activity. Comp. Haematol. Int. 9:49-53.
Pasha TN, Khan MZ, Farooq U (2009). Assessment of macro-minerals in soil, water, feed resources and its influence on blood plasma of sheep and goats in central mix cropping zone of Punjab, Pakistan. Trop. Subtrop. Agroecosyst. 11: 249-253.
Pastrana R, McDowell LR, Conrad JH, Wilkinson NS (1991). Macro-mineral status of sheep in the Paramo region of Colombia. Small Rumin. Res. 5:9-21.
Poland WW, Grings E, Karn J, Manske L (2001). Mineral concentration and availability of forages for grazing livestock in the Northern Great Plains. Dickinson Research Centre. Annual Report.
Remberg CF, Mayer GP, Kronfeld DS, Phang JM, Berman M (1970). Calcium kinetics in cows during late pregnancy, parturition and early lactation. Am. J. Physiol. 219:1166-1177.
Ricks M (1996). Minerals: Small Ruminant Series. Texas Agricultural Extension Service, Uvalde.
Robert PH (1989). Nutrition factors in bone health in elderly subjects, methodological and contextual problems. Am. J. Clin. Nutr. 50:1182-1189.
Robinson JJ, Ashworth CJ, Rooke JA, Mitchell LM, McEvoy TG (2006). Nutrition and fertility in ruminant livestock. Anim. Feed Sci. Techn. 126:259-276.
Rojas LX, McDowell LR, Wilkinson NS, Martin FG (1993). Mineral status of soils, forages, and beef cattle in South East Venezuela. I. Macro-minerals and forage organic constituents. Int. J. Anim. Sci. 8:183-188.
Shallow M, Ellis NJS, Judson GJ (1989). Sex related responses to vitamin B12 and trace element supplementation in prime lambs. Aust. Vet. J. 66:250-251.
Smith OB, Akinbamijo OO (2000). Micronutrients and reproduction in farm animals. Anim. Reprod. Sci. 60-61:549-560.
Standing Committee on Agriculture (1990). Feeding Standards for Australian Livestock. Ruminants. CSIRO: East Melbourne.
Suttle NF, Jones DG (1989). Recent Developments in Trace Element Metabolism and Function: Trace Elements, Disease Resistance and Immune Responsiveness in Ruminants. J. Nutr. 119:1055-1061.
Tainturier D, Braun JP, Rico AG, Thouvenot JP (1984).Variation in blood comparison in dairy cows during pregnant and after calving. Res. Vet. Sci. 37:129-131.
Tashi N, Xugang L, Shunxiang Y, Judson G (2005). A survey of the mineral status of livestock in the Tibet Autonomous Region of China. ACIAR working Paper No. 59.
Underwood EJ (1977). Trace Elements in Human and Animal Nutrition. 4th Edition, Academic Press, New York, USA.
Vázquez-Armijo JF, Rojo R, Salem AZM, López D, Tinoco JL, González A, Pescador N, Domínguez-Vara IA (2011). Trace elements in sheep and goats reproduction: A Review. Trop. Subtrop. Agroecosyst. 14:1-13.
Wani SA, Wani MH (2010). Marketing of Milk in Various Agro-climatic Zones of Jammu and Kashmir. Agri. Econ. Res. Rev. 23 (1):83-90.
Williams CH (1977).Trace metals and super phosphates: Toxicity problems. J. Aust. Inst. Agric. Sci. 43:99-109.
Yatoo MI, Saxena A, Jhambh R, Nabi S, Melepad DP, Kumar P, Dimri U, Sharma MC (2013). Status of Trace Mineral Deficiency in Sheep and Goat in Kashmir Valley. Res. J. Vet. Pract. 1(4):43-45.

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Scientific Research and Essays

Full Length Research Paper

Evaluation of management transfer of irrigation scheme in Düzce valley located in Western Black Sea Region of Turkey

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Management transfer of Düzce irrigation scheme was evaluated using appropriate performance indicators and the effects of farmers' opinions on water using and agricultural effectiveness. The results of the analysis indicated that the transfer process was not useful for farmers generally. Transfer management had no effect on sufficiency, equality, and irrigation time. However, maintenance of irrigation channels has gone better even though yet to be improved. Transfer affected management interest in the farmers' wish and suggestion positively, and farmers trusted the irrigation association. But, it is still needed that irrigation association should work on water distribution in the district. The irrigation association should repair the existing ones and construct new irrigation and drainage channel in the scheme network and organize meetings how to increase higher performance of irrigation management for farmers.

Key words: Irrigation, irrigation system performance, irrigation management transfer, Düzce irrigation scheme.

INTRODUCTION

Water shortage is a major problem in most countries especially river basins of the Eastern and Southern Mediterranean due to rapid growing up demographic and economic development, urbanization, industrialization, tourism, and inefficient agricultural activities, which is the prevailing water user. This case is exacerbate by low availability of renewable water, excessive use of the groundwater, pollution, inefficient infrastructure, and pronounced seasonality with unfavorable demand patterns which are very different from the seasonal supply (Nalliah et al., 2009).

In Turkey, 4.89 million ha of 8.50 million ha potential irrigating land area was opened to public and private irrigation presently. But, it has not still reached the expected level because remaining of total irrigating land area has not yet opened to public and private irrigation in Turkey (Anonymous, 2008).

Düzce valley, located in western Black Sea Region of Turkey, has very high agricultural potential, and 3% of agricultural land and rich natural resources with a very high quality of Turkey. Moreover, Düzce area is the leader concerning the water potential in the Black Sea Region in Turkey (Özmen, 2013). However, diffusion of agricultural pollutant into surface and underground fresh water resources, unsustainable urbanization and industrial development into the water supplying basins

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Figure 1. Location of Düzce Area in Turkey.

can affect the sources impairment negatively (Ahmed et al., 2012). Therefore it needs to study more about water management.

The performances of many irrigation system in developing countries are mostly far below their potentials. This failure is caused by the lack of an effective system of irrigation management, rather than problems in planning, project developing and construction (Mengü and Akkuzu, 2010). Hence, irrigation managers should have enough knowledge to make necessary and accurate decisions about increasing costs, and water distribution. Moreover, the government and local agencies should be involved in the management of such projects since irrigation has a socio-political importance (Douglas, 2009).

Study done by Tanrıverdi and Değirmenci (2011) showed that the program of irrigation transfer management had no effect on indicators of water use efficiency such as sufficiency, equality, and irrigation time; it had negative effects on maintenance and operation of irrigation and drainage channels. Additionally, farmers had insufficient knowledge of the transfer of irrigation management and did not understand the transfer of management, which indicates that one of the major aims of the transfer program. However, Tanrıverdi and Değirmenci (2011) received different results when compared with the results of Nalbantoğlu and Çakmak (2007). In this context, the results of these studies can show variability according to region due to social and cultural background.

The aim of this study was to evaluate the effectiveness of the irrigation transfer program in the Düzce valley. Therefore, questionnaires in which included the success of water distribution criteria, such as sufficiency, equality, and safety of the program were applied to local farmers, village heads, association personnel and managers in Düzce irrigation district in Düzce area in Turkey.

MATERIALS AND METHODS

Studied area is located in the Düzce irrigation district under serving fifth State Hydraulic Works (SHW) in Düzce in Turkey (Figure 1). Irrigation water is supplied from Hasanlar Dam in Düzce Area. The scheme of Düzce irrigation which was put into operation in 1975 by SHW under 11.000 ha irrigation area of 20.000 ha irrigable area and transferred to Water Use Associations (WUAs) in 2005 (Özmen, 2013).

For determination of the success of water distribution, sufficiency, equality, trust towards the irrigation association and the timing of irrigation were used. In determining the indicators, the questionnaires were administered to farmers, village heads, association personnel and managers (Vermillon, 2000).

RESULTS AND DISCUSSION

Four questions were asked to farmers about the sufficiency of water distribution before and after the transfers (Figure 2). Water delivery by irrigation scheme and utilization of water by farmers from drainage channels

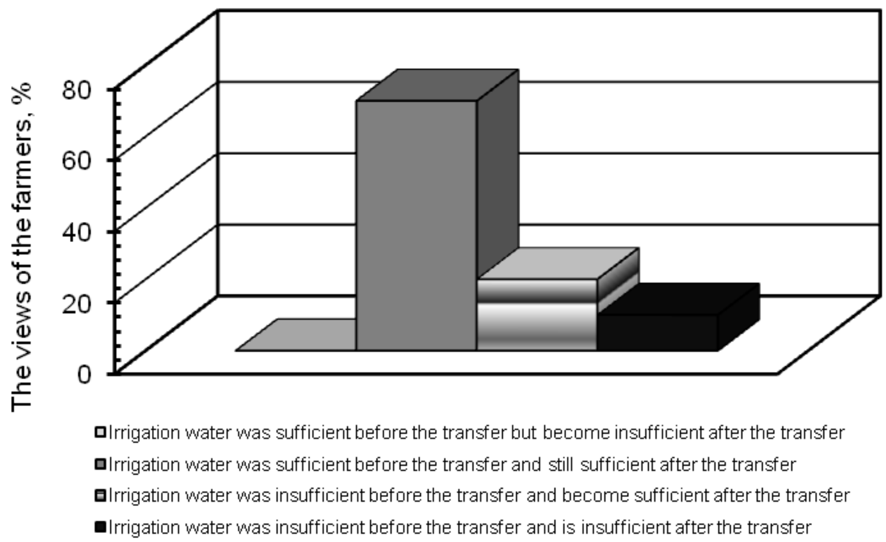

Figure 2. Farmers' status on receiving sufficient irrigation water.

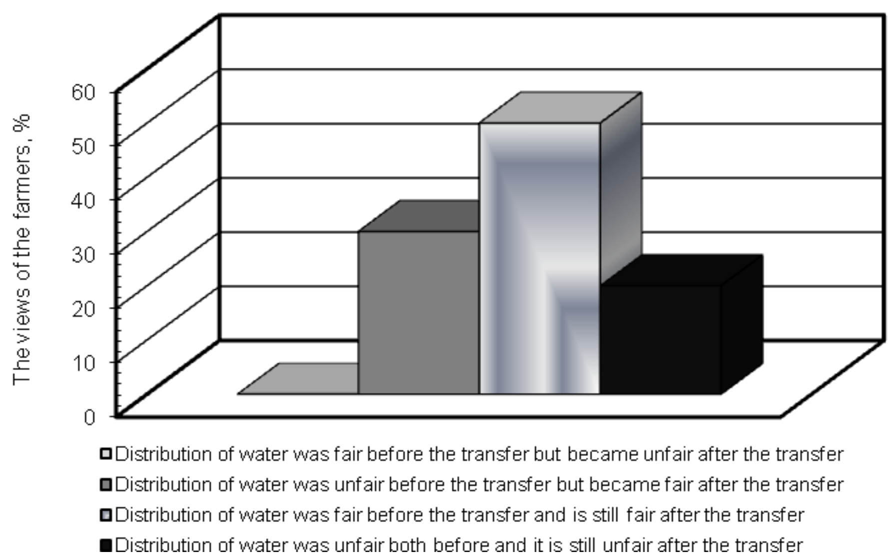

Figure 3. Farmers' views on equal distribution of water.

and ground water were evaluated. Additionally, farmers' irrigating at night was also included to evaluate. However, farmers received water sufficiently from irrigation channels, 70% of farmers received water sufficiently before the transfer and still sufficient after the transfer; 20% reported that they received insufficient water before the transfer and become sufficient after the transfer. A total of 10% of farmers got water insufficiently before the transfer and insufficiently after the transfer while a total of 0% of farmers received sufficiently before the transfer but become insufficiently after the transfer (Figure 2). This work indicated that farmers mostly received water sufficiently for that transfer management is well. Study results are similar to studies done by Tanrıverdi (2011).

Figure 3 shows farmers' views about the fair distribution of water before and after the transfer. 50% of the farmers reported that distribution of water was fair before the transfer and is still fair after the transfer while 30% of the farmers reported that distribution of water was unfair before the transfer but became fair after the transfer. 0% of farmers responded that distribution of water was fair before the transfer but became unfair after the transfer while 20% of farmers reported that distribution of water was unfair both before and it is still unfair after the

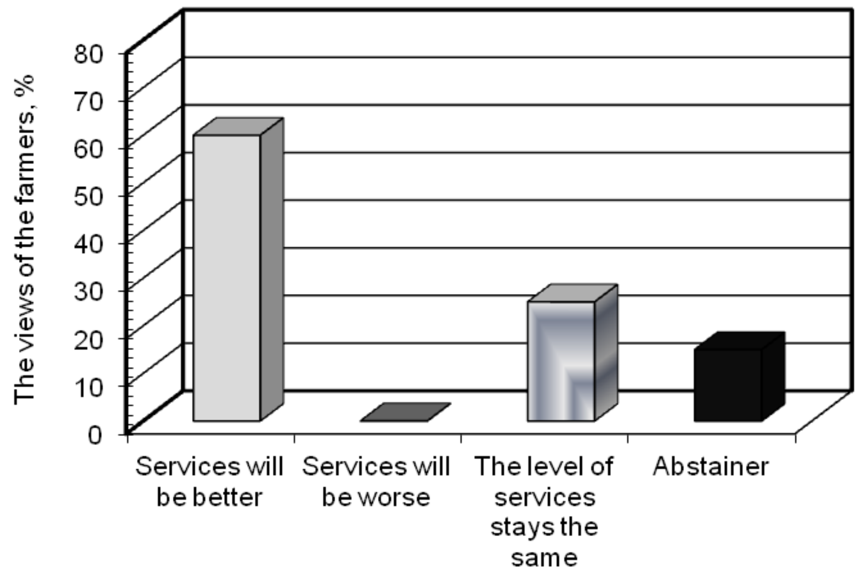

Figure 4. Farmers' views about the sustainability of the irrigation association.

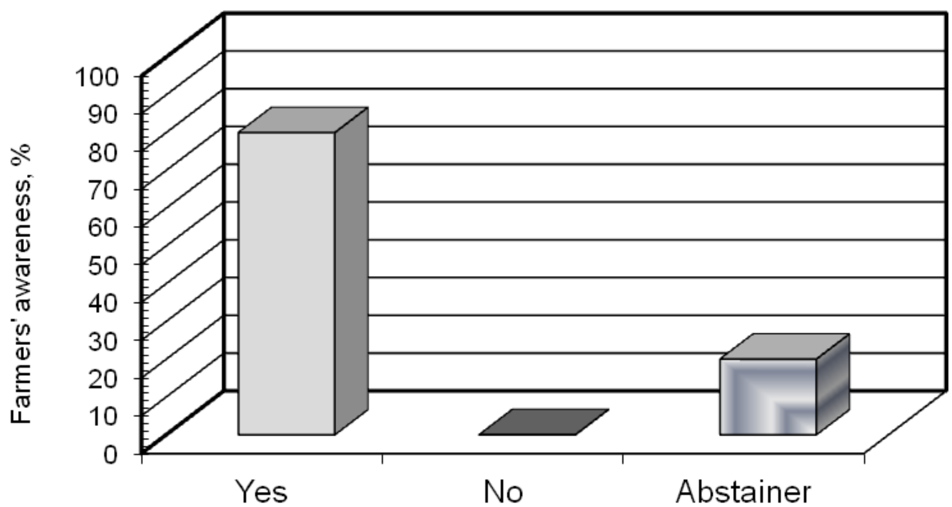

Figure 5. Farmers' awareness of funding the operation-maintenance-management (OMM) services through water fees.

transfer. Yercan et al. (2009) found that Water User Associations (WUAs) performed better than cooperatives when they searched general aspects of irrigation performance in Gediz River Basin in Turkey. Therefore, results can be changed according to region thanks to management and social status of region.

As indicated in Figure 4, farmers were questioned on their trust in the management of the irrigation association. This is related to operation-maintenance management (OMM) services of irrigation association. 60% of farmers expected that the OMM services of irrigation association would be better while no one was thinking OMM services would not be worse in the subsequent years. Additionally, a total of 25% of the farmers thought that OMM services would remain the same while 15% abstained in this issue (Figure 4). The study show that farmers generally believe the irrigation association but it is still needed to be recovered the irrigation management of irrigation union. Moreover, this study results conformed with study done by Nalbantoğlu and Çakmak (2007).

Farmers were questioned if they were aware of the irrigation fees collected that was used for OMM water fees. According to results; 80% of farmers were aware of that (Figure 5). Views of farmers on this issue were

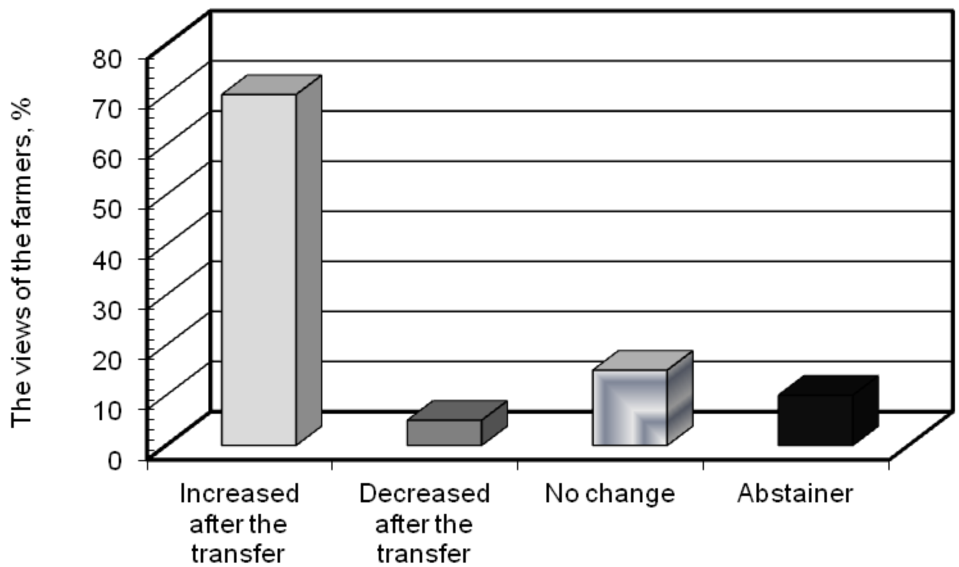

Figure 6. Management interest in the farmers' wishes and suggestions.

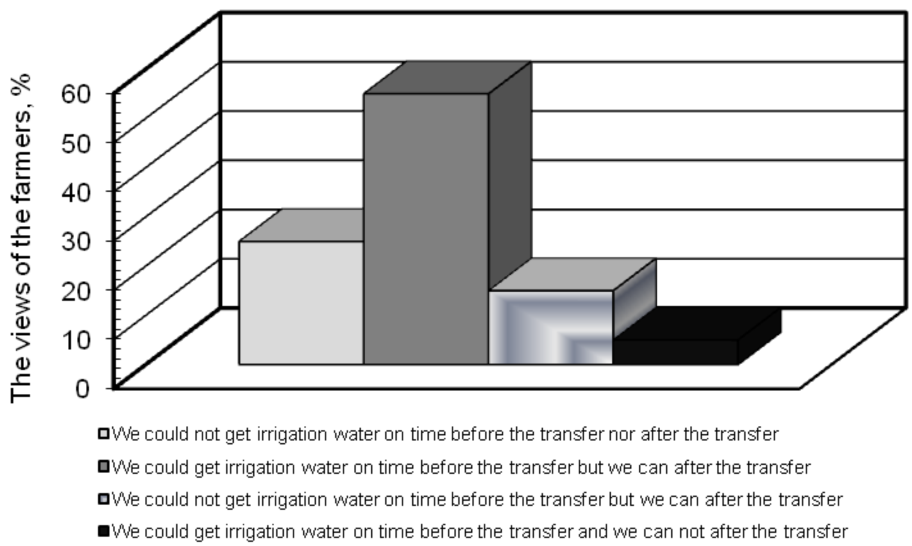

Figure 7. Farmers' views on receiving irrigation water on time.

indicated in Figure 6. A total of 70% of the farmers explained that the management was more interested in farmers' views after the transfer while 5% explained that the interests of irrigation management decreased after the transfer. Moreover, 15% explained that there was no change in the interest shown by the management while 10% of the farmers abstained. At this point, irrigation union performed well for its activity but not enough. On the other hand, similar results were obtained by Tanrıverdi and Değirmenci, (2011).

Figure 7 shows farmers' views about irrigation timing. A total of 55% of the farmers reported that they received irrigation water on time before the transfer but they can after the transfer while a total of 25% of the farmers did not received irrigation water on time before transfer nor after the transfer. Additionally, 15% explained that they were not able to get water on time before the transfer, but were able to get water on time after the transfer while 5% reported that they were able to get irrigation water on time before the transfer, but were unable to get water on time after the transfer (Figure 7). According to results, farmers did not mostly received irrigation water on time after transfer. The reason is due to management of irrigation union. Study results were similar with a work

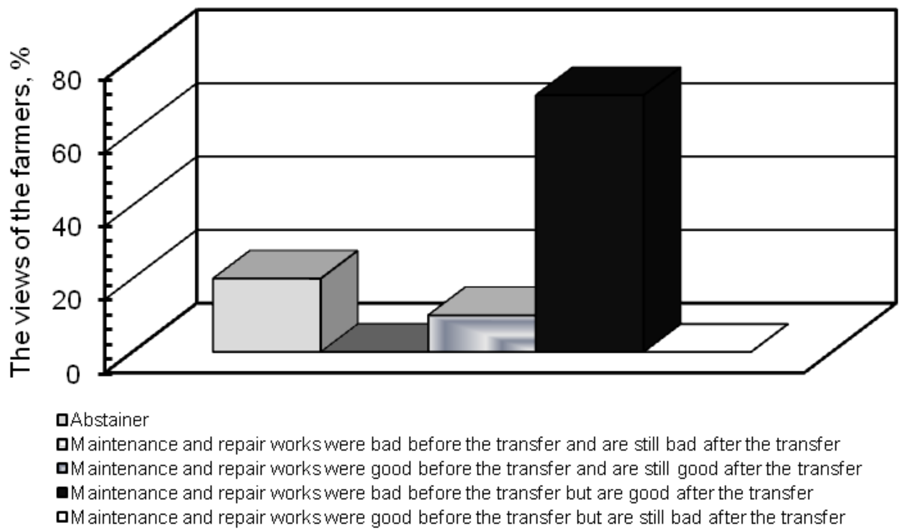

Figure 8. Views on the maintenance and repair of irrigation channels.

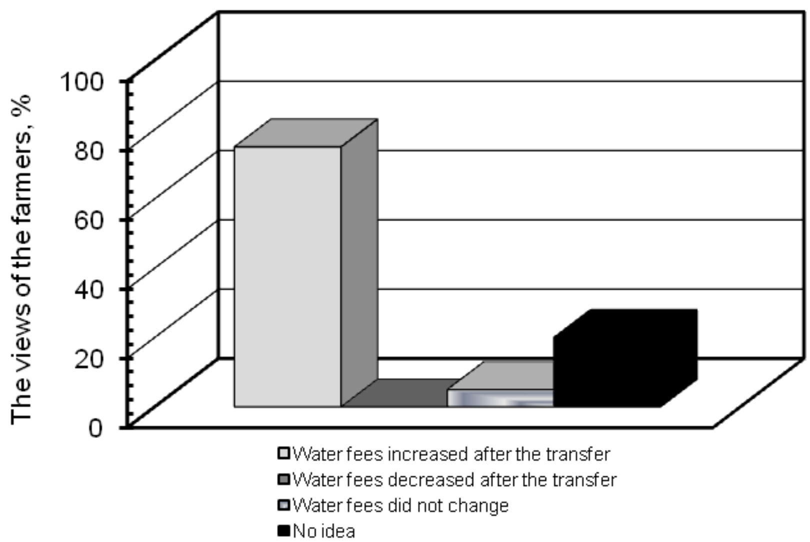

Figure 9. Changes in irrigation water fees.

done by Tanrıverdi and Değirmenci, (2011) but lower than the results found by Nalbantoğlu and Çakmak (2007). Views of farmers on the maintenance and repair of irrigation channels are shown in Figure 8. A total of 70% of the farmers explained that the maintenance and repair works were bad before the transfer but were still good after the transfer while 10% of farmers reported that these maintenance and repair works were good before the transfer and are still good after transfer. According to results; abstainer were 20% while other question were not answered (Figure 8). Irrigation management transfer has not been active to the maintenance and repair works of irrigation scheme (Dorsan et al., 2004). This situation can be explained due to administrative of irrigation union.

Changes in water fee before and after the transfer of management are given in Figure 9. A total of 75% of the farmers reported that irrigation water fees increased after the transfer while 5% explained that fees did not change after the transfer. Moreover, 20% of farmers had no idea about transfer of management. This increase can be related with expenses of OMM. Figures 10 and 11 show the views of the farmers about the appropriateness of the maturity data and payment date of water fees and payment alternatives for water fees, respectively. A total 45% of the farmers reported that maturity and payment dates were appropriate before the transfer but they are not appropriate after the transfer while 25% of the farmers reported that maturity and payment dates were

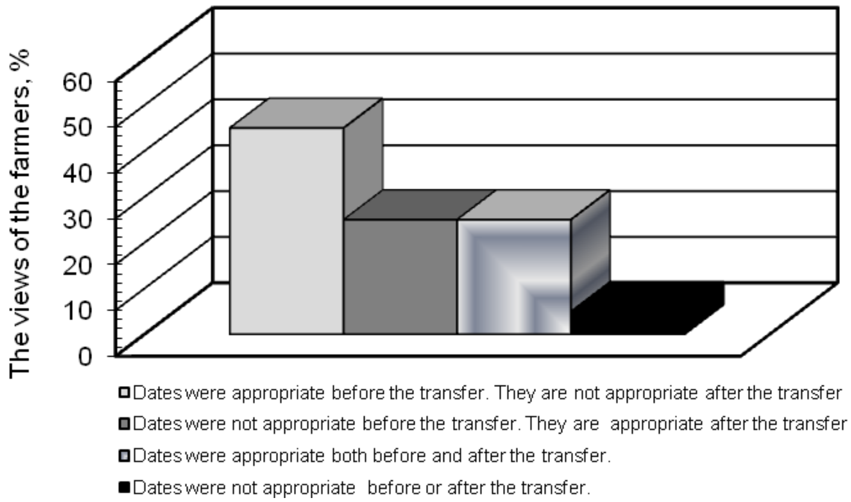

Figure 10. Maturity and dates of water fees.

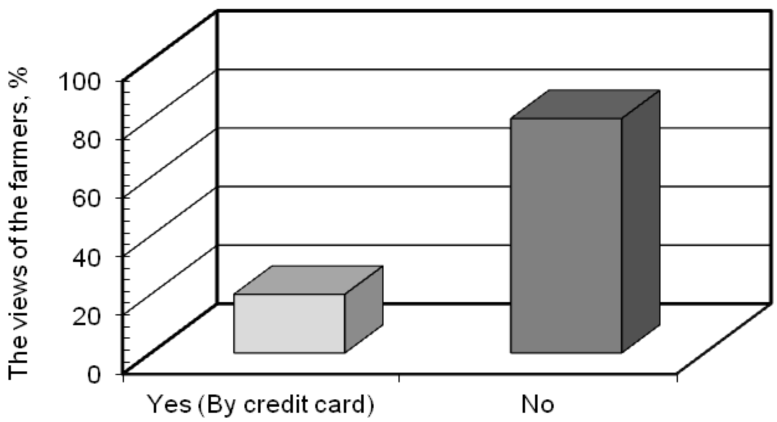

Figure 11. Payment alternatives for water fees.

not appropriate before the transfer but they are appropriate and, maturity and payment dates were appropriate before and after the transfer. Additionally, 5% of the farmers reported that maturity and payment dates were not appropriate before and after the transfer. A total 80% of farmers reported that payment alternative for water fees were cash while 20% of farmers explained that payment alternative for water fees were by credit card. According to these results, the reasons which farmers have not mostly been receiving water on time can be due to technical information of farmers and personnel of irrigation union, and distribution of network. Similar results can be found in the study reported by Tanrıverdi and Değirmenci, (2011).

Conclusion

Results of the study, it was achieved that the transfer did not have effect on the general scheme of Düzce irrigation except maintenance and repair of irrigation channels. However, it was found that the farmers trusted the irrigation association and the transfer had a positive impact on the management interest in the farmers wish and suggestion. This study showed that farmers were aware of funding the OMM services through water fees. Moreover, farmers explained negative views about the water distribution performance of after the transfer. This case pointed out that water is not distributed effectively throughout the irrigation network. The results emphasized that water fees were increased and maturity and dates of water fees were bad after the transfer. There was no need payment of alternatives after the transfer. It was concluded that the irrigation association should repair or reconstruct the places of scheme network for higher water distributions, sufficient irrigation water deliver and on time. On the other hand, it should carried out more activities to meet farmers for maintaining the network and be taken into consideration farmers' requirement such as water fee increase and date and maturity of water fee.

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Conflict of Interest

The author(s) have not declared any conflict of interests.

REFERENCES

Ahmed FRS, Alexander IJ, Mwinyihija M, Killham K (2012). Effect of arsenic contaminated irrigation water on *Lens culinaris* L. and toxicity assessment using *lux* marked biosensor. J. Environ. Sci. 24:1106-1116.

Anonymous (2008). Soil and Water Resource. General Administration of the State Hydaulic Works, Operation and Maintenance Unit (in Turkish), Ankara, Turkey.

Dorsan F, Anaç S, Akçay S (2004). Performance Evaluation of Transferred Irrigation Schemes of Lower Gediz Basin. J. Appl. Sci. 4:231-234.

Douglas A (2009). Social, Political, and Institutional Setting: Water Management Problems of the Rio Grande. J. Water. Resour. Plann. Manag.135:493-501.

Mengü GP, Akkuzu E (2010). Impact of Irrigation Management Transfer on Land and Water Productivity and Water Supply in the Gediz Basin. Turkey. J. Irrig. Drain Eng. 136:300-308.

Nalbantoğlu G, Çakmak B (2007). Benchmarking of Irrigation Performance in Akıncı Irrigation District. Journal of Agricultural Sciences, Ankara University Faculty of Agriculture, 13:213-223.

Nalliah V, Sri Ranjan R, Kahimba FC (2009). Evaluation of a plant-controlled subsurface drip irrigation system. Biosystems Eng. 102:313-320.

Özmen S (2013). Irrigation Water Use and Water Table in Düzce Area. Düzce University J. Sci. Tech. 1:47-57.

Tanrıverdi Ç, Değirmenci H (2011). Assessment of management transfer of Kahramanmaras irrigation system. Sci. Res. Essays. 6: 522-528.

Vermillon DL (2000). Guide to Monitoring and Evaluation of Irrigation Management Transfer. International Network on Participatory Irrigation Management, USA.

Yercan M, Atis E, Salali HE (2009). Assessing irrigation performance in the Gediz River Basin of Turkey: Water User Associations Versus Cooperatives. Irrigat. Sci. 27:263-270.

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