ISSN 2250-3153

Carbon Credits: A Climate change Mitigation Strategy

Vaibhav S. Malunjkar*, Santosh K. Deshmukh, P. Balakrishnan***

* Department of Soil and Water Engineering, University of Agricultural Sciences Raichur 584 102, Karnataka
** Jain Irrigation Systems Ltd,, Jalgaon 425 001, Maharashtra

Abstract- Greenhouse gases (GHGs) are mainly responsible for global warming which is most dreaded problem of the new millennium. Electricity generation based on fossil fuel is the major source of emission of GHGs. In India about 52 per cent of its total electricity is generated using fossil fuel (coal). Indian agriculture consumes about 30 per cent of its total electricity. There is vast scope in minimizing the GHGs emission caused by power consumption in agriculture sector by adopting energy efficiency tool viz: modern irrigation methods like micro irrigation.

India is the world's largest producer of banana (Musa sp.) having about 27 per cent share of the global output. Irrigation of banana is one of the major consumers of water and energy. Hence, a field study was conducted on banana crop in Jalgaon district of Maharashtra for evaluating energy efficiency of two irrigation methods, namely, micro irrigation system (MIS) and the conventional flood irrigation (FI). The study revealed that water saving of 32% and electricity saving of about 36% was achieved by micro irrigation against the flood irrigation. The potential of gaining carbon credits by switching from flood irrigation to MIS for 5,000 ha area under banana crop in Jalgaon district was estimated at 11,750 (tCO_2e or carbon credits) worth Rs. 2000/ha. Thus, micro irrigation has a definite role in minimizing the impacts of climate change on Indian agriculture by reducing the consumption of water and electricity.

Index Terms- Banana, carbon credits, climate change, micro irrigation

I. INTRODUCTION

Conventional irrigation methods are employed for more than 80 per cent of the world's irrigated lands yet their field level application efficiency is only 40-50 per cent (Sivanappan, 2005). In contrast, drip irrigation has field level application efficiencies of 70-90 per cent as surface runoff and deep percolation losses are minimised (Westarp *et al.,* 2004). All agricultural operations require energy in the form of electricity, the magnitude of which varies as per different agro-climatic zones and even from farmer to farmer. The largest share of energy is utilized for pumping of irrigation water. Various research studies have shown that water saving, electricity saving, irrigation efficiencies and yield of crops using drip irrigation are substantially higher than crops irrigated by the conventional flood irrigation method (INCID, 1994; Magar et al., 1998; Narayanamoorthy, 2007).

In India about 52 per cent of its total electricity is generated using fossil fuel (coal). Indian agriculture consumes about 30 per cent of its total electricity (Rekha Krishnan, 2009). According to BERI (2007), India is among the 10 fastest growing economies in the world. Due to this its fossil fuel share is expected to rise to 74 per cent of total energy by 2010, the corresponding increase in CO_2 emissions being 1,646 Million tons. The use of fossil fuels increases the Greenhouse gases (GHGs) emission. Thus, energy efficiency in agriculture has huge impact on overall power scenario in India. The United Nations Framework on Climate Change (UNFCCC) has made it mandatory that any carbon saving in the developing world, which could be traded with the developed world, has to be duly validated through certified emission reductions (CERs). Any work attaining saving of electricity by various means in the developing world can sell these certificates to any entity in the developed world. This trading could be done at a mutually agreeable price.

In case of horticultural crops, Banana (*Musa sp*.) is a globally important fruit crop produced in tropical and subtropical regions of developing countries with 97.5 Million tons of production. India is the world's largest producer of banana, accounting for about 27 per cent of the global output. At the same time, banana crop is one of the major consumers of water and energy. In this context, it would be interesting to evaluate the savings of water and electricity for banana crop due to use of drip irrigation as against the conventional irrigation. Hence, a pilot study was undertaken to generate the scientific information about water and power savings and standardize the same to assess the carbon credits that could be gained by adoption of drip irrigation.

II. METHODOLOGY

Location and treatment details: A study was conducted at two different locations in Jalgaon district of Maharashtra ($21^0$01' N, $75^0$34' E and 209 m above MSL), one being at the Research and Development Farm of the Jain Irrigation Systems Ltd. Jalgaon and another in the farmer's field in Raver tehsil of Jalgaon district. In both the fields, soils are well drained (infiltration rate being 1.68 and 1.59 cm/h respectively) and slightly alkaline (pH being 7.7 and 7.65 respectively) with good water holding capacity. Banana crop (Musa sp.) cv. Grand Naine (tissue cultured) was planted at a spacing of 1.82 x 1.82 m. The trials were conducted on both drip irrigation (MIS) and flood irrigation (FI). In both trials the same plant population was maintained and irrigation was applied by considering 100 per cent evapotranspiration.

Water and electricity savings: The observations such as number of pumping hours, water consumption (kL) with the use of water meter and electricity consumption (kWh) with the help of energy meter were recorded separately during the study. For both MIS and FI, the savings in water and electricity were found from these observations.

ISSN 2250-3153

Emission reductions: The main object of the study was to reduce water consumption, and thereby, reduce the electricity consumption with the introduction of drip irrigation. The reduction in electricity consumption ultimately leads to the reduction of carbon dioxide (CO2) emissions. For the determination of CO2 emission reductions, specific electricity consumption (SEC) and grid emission factors were calculated.

$$SEC = \frac{EC}{A} \qquad \text{(Eq. 1)}$$

Where,

SEC = Specific electricity consumption in the treatments (kWh/ha)
EC = Electricity consumption in the treatments (kWh)
A = Area under the treatments (ha).

CO_2 emission reductions and carbon credits: Then carbon dioxide (CO2) emission reductions due the introduction of MIS in the study area were estimated as,

$$CO_2 \text{ emission reductions} = (SEC_{FI} - SEC_{MIS}) \times EF \qquad \text{(Eq. 2)}$$

Where,

SEC_{MIS} = Specific electricity consumption in drip irrigation treatment (kWh/ha)
SEC_{FI} = Specific electricity consumption in flood irrigation treatment (kWh/ha)
EF = Grid emission factor (tCO_2/MWh)

Grid emission factor (EF) is the tonnes of CO_2 emissions in the atmosphere during one megawatt (MW) electricity generation in the thermal power plants. The value of grid emission factor (EF) for north India is 0.8401 tCO_2/MWh for the year 2009-10 (CEA, 2008). From the electricity consumption in flood and drip irrigation methods, the CO_2 emission reductions of the study area Jain R & D farm and farmer's field were computed. Using these values the CO_2 emission reductions were projected for the entire Jalgaon region by multiplying the total area under banana cultivation.

According to Kyoto Protocol and methodologies, suggested by the UNFCCC for energy efficiency in agriculture, the potential of carbon credits was estimated. According to the UNFCCC, one carbon credit is equal to one tonne CO_2 reduction which is also called as Certified Emission Reductions, CERs (Gold Standards, Version 2, 2009). The gain of carbon credits by improving energy efficiency of banana and electricity savings in pumping of water due to drip irrigation was then calculated from the total emission reductions obtained in the study.

III. Results

Water and electricity consumption: The number of irrigations applied, the number of pumping hours and the water and electricity consumption in both, flood and drip irrigated fields are given in Table I & II and are depicted in Figure I. To constantly maintain the moisture level at field capacity in the root zone of the plants, the numbers of irrigations were high in MIS, but the quantity of water applied was significantly less than that in flood irrigation. The numbers of pumping hours in MIS were less than 25 per cent as that of flood irrigation.

A significant saving of water in MIS of about 35.14 and 29.24 per cent in the two fields was noted as against the flood irrigation. Similarly, the saving in electricity of 38.96 and 33.41 per cent was observed in MIS against FI.

Table I. Irrigation water and electricity consumption in irrigation methods (Jain R & D Farm)

Particulars	**Jain R & D Farm**		
	MIS	**FI**	**% saving in MIS over FI**
Depth of irrigation applied (mm/ha)	1455.6	2244.2	35.14
Total water consumption (kL/ha or m^3/ha)	14,556	22,442	35.14
Total electricity consumption (kWh/ha)	4657.8	7630.3	38.96
Total number of irrigations applied	151	40	-
Total pumping hours used for irrigation application (h/ha)	397.7	1726.3	-
Hours used per irrigation	2.6	43.2	-

Table II. Irrigation water and electricity consumption in irrigation methods (Farmers field)

Particulars	**Farmers field**		
	MIS	**FI**	**% saving in MIS over FI**
Depth of irrigation applied (mm/ha)	1669.7	2359.8	29.24
Total water consumption (kL/ha or m^3/ha)	16,697	23,598	29.24
Total electricity consumption (kWh/ha)	5343	8023.5	33.41
Total number of irrigations applied	126	42.1	-
Total pumping hours used for irrigation application (h/ha)	456.2	1815.3	-
Hours used per irrigation	3.6	43.1	-

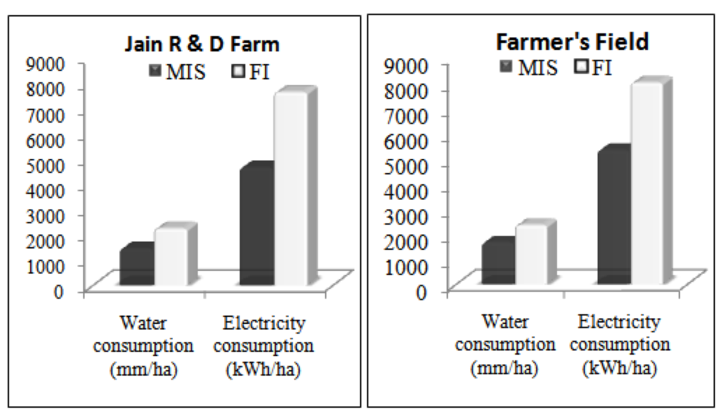

Figure I. Water and electricity consumption

Carbon credits analysis: The use of drip irrigation for banana cultivation, due to it's saving in electricity, has a large potential for carbon credit gains. The carbon credits gain by use of drip irrigation over FI was calculated for both the fields using Eq. 2 as shown in Table III. The carbon credits gain in Jain R & D farm and the farmer's field were found to be 2.5 and 2.2 tCO_2e/ha respectively. The value for R & D farm is higher over the farmer's field on account of the greater precision exercised during the irrigation process. The saving of carbon credits as per the current price of Rs. 850 (€13) amounts to a monetary gain of 1997.5 Rs./ha (average).

The potential of carbon credits gain projected for the area of 5,000 ha in Jalgaon district using average value of 1997.5 amounts to 11,750 tCO_2e and it will lead to monetary benefits of Rs. 10 Million per year.

Table III. Potential carbon credits gain in banana cultivation in Jalgaon district

Sr. No	Particulars	Jain R & D Farm		Farmer's field		Average
		MIS	FI	MIS	FI	
1	SEC (kWh/ha) as per Eq. 1	4657.8	7630.3	5343	8023.5	-
2	CO_2 emission reductions (tCO_2e/ha)* as per Eq. 2	2.5		2.2		2.35
3	Projected potential of emission reductions from Jalgaon district (tCO_2e/yr) (Row 2 x 5,000***)	11,750				
4	Monetary Potential of carbon credits (CERs) gain due to MIS (Rs./ha) (Row 2 x 850**)	2,125		1,870		1997.5
5	Projected potential of carbon credits gain from Jalgaon district (Rs. Lakh) (Row 4 x 5,000***)	Rs. 100 Lakh				

*Grid emission factor = 0.0008401 tCO_2e/kWh
**Current price of carbon credit = Rs.850
*** Per 5,000 ha area under banana cultivation

IV. CONCLUSION

The present study clearly indicates the positive impact of drip irrigation technology on climate by reduction of carbon emissions effected due to water and power saving for banana cultivation as against flood irrigation. Thus, if drip irrigation is adopted largely for various crops in India it can enormously help in countering the problems of global warming and climate change apart from generating revenue by sale of carbon credits.

ACKNOWLEDGMENT

This study is based on work supported by Jain Irrigation Systems Ltd., Jalgaon. Also technical guidance from the Department of Soil and Water Engineering, UAS, Raichur has made this project possible

REFERENCES

[1] BERI, 2007. Biomass Energy for Rural India, http://nitpu3.kar.nic.in/bioenergyindia.

[2] CEA, 2008. All India Electricity Statistics general review. Central Electricity Authority, Government of India, New Delhi.

[3] Gold Standards, Version 2, 2009. Premium quality carbon credits, www. cdmgoldstandard.org/gsv2_toolkit.pdf.

[4] INCID, 1994. Drip irrigation in India. Indian National Committee on Irrigation and Drainage, New Delhi.

[5] S. S. Magar, N. N. Firke and J. R. Kadam, 1988. Importance of drip irrigation. *Sinchan*, 7(2): 61–62.

[6] A. Narayanamoorthy, 2007. Micro-irrigation and electricity consumption linkages in Indian agriculture: a field based study. Abstracts International Conference on linkages between Energy and Water Management for Agriculture in Developing Countries, Hyderabad, India, 29-30 Jan. 2007.

[7] Rekha Krishnan, 2009. India's energy security: imperatives for change. *Energy Sec. Insights*, 4(4): 2.

[8] R. K. Sivanappan, 2005. To overcome the demand for water. *Kisan World*. 32(8): 47.

[9] S. V. Westarp, S. Chieng and H. Schreier, 2004. A comparison between low-cost drip irrigation, conventional drip irrigation, and hand watering in Nepal. *Agriculture Water Management*.,64:143-160.

AUTHORS

First Author –
Er. Vaibhav S. Malunjkar, M.Tech (Ag. Engg), Research Scholar, MPKV Rahuri. Email: vaibhav.agroneer@gmail.com
Second Author –
Dr. Santosh K. Deshmukh, Ph.D. (Ag. Engg), Chief coordinator, Jain Irrrigation Systms Ltd., Jalgaon.
Email: deshmukh.santosh@jains.com
Third Author –
Dr. P. Balakrishnan, , Ph.D. (Ag. Engg), Dean, College of Agricultural Engineering, Raichur.

Correspondence Author – Er. Vaibhav S. Malunjkar, Email: vaibhav.agroneer@gmail.com, Mob: +91-8275583808