Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 5, Number 1, 2014, 70-103

Improving Sustainable Vegetable Production and Income through Net Shading: A Case Study of Botswana

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Abstract. Poor and seasonal production of vegetables has been a problem in Botswana which leads to dependency on imported vegetables. Among others, damage caused by sunburn and birds are important causes for poor production of vegetables. There was a need to explore strategies to minimize the damage caused by sunburn and birds and therefore, to increase the vegetable production. The shade net was found to be a suitable strategy to improve vegetable production by reducing the damage caused by sunburn and birds. The shade net project was planned and implemented in year 2012 at Livingstone Kolobeng College in Gaborone, Botswana (Southern Africa) aiming at improving the vegetable production and therefore, income. The specific objectives of the project were to increase the production and supply of quality vegetables to the school community, to generate additional income by sale of vegetables produced and, to create a demonstration and practical unit for students. All the basic steps considered in designing an effective project such as situation analysis, stakeholder analysis, problem analysis, objective analysis, strategy analysis, log frame analysis, scheduling, swot analysis, budgeting, appraisal and monitoring and evaluation has been presented and discussed. The impact evaluation of the project has given positive results whereby the total vegetable production and the income has increased by 162% and 103%, respectively. The project can be replicated to other schools, government offices, organizations and vegetable farmers not only in Botswana but also in other African countries.

Keywords: Shade net, Sun burn, Vegetable Production, Log frame analysis, SWOT analysis, Budgeting, Impact evaluation

INTRODUCTION

Botswana is not self sufficient in horticultural production and depends on the imports, especially from South Africa. The Horticulture sub-sector in Botswana is considered one of the priority areas for diversification not only the agricultural sector but also diversification of economy of the country because of its important role in creating employment, investment opportunities and increasing agricultural sector contribution to the Gross Domestic Product (GDP) which has been declining since independence (Seleka, 1999; Anon, 2009). The 2008/2009 national demand for vegetable crops was estimated at 50 000 metric tons for vegetables, while local production for the same year was 31 150 metric tonnes. During National Development Plan 9 (NDP9) production per demand increased from 20% to 40%, while production for 2008/09 satisfied 51% of the national requirement (Anon, 2009). Despite this increase, Botswana still imports fresh horticultural produce (fruit and vegetables) worth about P200 million monthly mainly from the Republic of South Africa (TAHAAL, 2000). Observing the demand and production gap, there is huge market potential which offers the scope for increasing horticultural production the the country.

Farming in Botswana, especially vegetable farming face a problem of low yield which varies year to year and season to season due to variation in environmental stresses like drought, poor water availability, pest and diseases and extreme temperatures. Environmental stress such as sunburn and damage by birds are the primary cause of crop losses worldwide, reducing the average yields for most major crops by more than 50% (Boyer, 1982; Bray et al, 2000). Sunburn in vegetable crops is caused by high temperature whereby the sunlight can scorch the vegetative parts of plants (Shef & Macnab, 1986). Birds can damage foliar parts of leafy vegetable crops such as rape and spinach. High and low temperature can result into poor growth of plants (Kalloo, 1986). The horticultural crops are produced in backyard gardens, school gardens and commercial plots and mostly by subsistence farmers across the country. The effort to increase horticultural production is constrained by among other factors of poor soils, shortage of water, extreme temperatures, sunburn, pest and disease

including bird's damage (Baliyan and Kghati, 2009). While the vegetable growers may be aware of these constraints, it is important to point out that the vegetable production in the country has been poor and cannot produce vegetables at sustainable level to meet the local demand. Growing vegetable crops under protection can contribute to overcome these problems in order to get high yields of good quality. Protective cultivation involves more sophisticated techniques than unprotected cultivation in the field. Protective covering vary from shade netting and simple film plastics (passive protected cultivation) to structures with glass or rigid sheet plastic and equipped with sophisticated environmental controls (active protected cultivation) (Kozai, 1988). Passive protected cultivation refers to structures where environmental control equipments are absent or simple in order to minimize the initial cost and running costs. Active protected cultivation refers to systems where the environment is actively managed and is very costly as compare to passive protected cultivation (Kozai, 1988).

Protective cultivation has been widely applied due to adverse climatic conditions unfavourable to warm season vegetable production. In many parts of the world, nets or screens are commonly used in crop production for reducing excessive solar radiation, weather effects on produce, and to keep away insects and birds. Structures made from netting have different names, e.g., nethouse, net house, and net greenhouse, indicating a lack of standardization of this production system. Journal article search by the authors provided some interesting articles on shade cloths (popular worldwide) and insect netting (popular in Africa) for fruit and vegetables. Vegetable production under protective structures such as netting reduces yield losses from insects, diseases, heavy rains and sunburn which results in higher productivity and returns per unit area (Ramasamy, 2011). Protective structures provide protection to vegetable crops against biotic and abiotic stresses (Palada, 2011). Mangmang (2002) reported that the total fruit yield and high returns of tomato crop was significantly enhanced by the plastic net covers. The net shade greatly reduced insect population by 80% and marketable yields were 1.5 to 2 times greater under than in the open field (Palada and Ali, 2007). Growing cabbage under nets reduced insect incidence by

38-72% and resulted in significantly higher returns (Neave et al, 2011). Green house, the latest word in agriculture is one such means, where the plant are grown under controlled or partially controlled environment resulting in higher yields than that is possible under open conditions (Navale *et al*., 2003). Net houses and its variants have been used in some European, South American and Southeast Asian countries for producing egg plants (Kaur et al., 2004), leafy greens (Talekar et al., 2003) and cabbage (Martin et al., 2006). In Africa, mobile net houses made of mosquito nets (25-mesh) were effective as physical barrier against the diamondback moth, cutworms, and loopers providing 66 to 97% control of moths, birds and caterpillars (Martin et al., 2006). Netting is frequently used to protect agricultural crops from excessive solar radiation (shade-nets), improving the thermal climate (Kittas et al., 2009), sheltering from wind and hail and exclusion of bird and insect-transmitted virus diseases (Teitel et al., 2008). The shading of crops results in number of changes on both local microclimate and consequently crop growth and development (Kittas et al., 2009). Takte *et al.* (2003) reported that shade nets were used for protection of valuable crops against excess sunlight, cold, frost, wind and insect/birds. They experimented on the effects of shading on crop growth and development, it was found that shading increased leaf area index and total marketable yield production, reduced the appearance of tomato cracking about 50% and accordingly, the marketable tomato production was about 50% higher under shading conditions than under non-shading conditions. Smith et al. (1984) observed that under shading nets the air temperature was lower than that of the ambient air, depending on the shading intensity. Shade netting not only decreases light quantity but also alters light quality to a varying extent and might also change other environmental conditions. The shade netting determines the commercial value of crop, including yield, product quality, and rate of maturation (Shahak et al., 2004). Poor head formation, leaf twisting, early bolting, and reduced yields occurred when leafy vegetables were grown under hot, high-sunlight conditions without shade net (Nothmann, 1977; Sajjapongse and Roan, 1983). Water stress caused by high evapotranspirative demand, and high

air and soil temperatures, appear to be the main causes of poor crop productivity of leafy crops in low-latitude regions (Wolff and Coltman, 1990).

Observing the fact of the poor and seasonal production of vegetables in Botswana and the advantages of the protective cultivation (shade net), there was a need to plan, implement and evaluate this cultivation strategy and technique (shade netting) for improvement in the vegetable production. Therefore, this study was conducted to develop a net shaded area so as to reduce the damage caused by birds and sunburn and thus, increase vegetable production and ensure constant supply throughout the year. This project aimed at improving the vegetable production through establishing a shade net (passive protected cultivation). The specific objectives of the project were:

1. To create and provide a demonstration and practical unit for the students doing agriculture
2. To increase the production and supply of quality vegetable to the community
3. To generate additional income by sale of vegetables.

METHODOLOGY

The Livingstone Kolobeng College in Gaborone, Botswana (Southern Africa) has developed a school garden which not only caters for the practical and project needs of the students as per their agriculture syllabus; but also provides vegetables to the school community including teaching staff members. The methodology of this project includes most of the basic steps considered crucial in planning and evaluating a project such as problem analysis, objectives analysis, strategic analysis, scheduling, logframe analysis, budgeting, project appraisal, monitoring and evaluation steps in project designing were carried. The participatory approach was employed to conduct the steps of the problem analysis, objectives analysis, strategic analysis and project appraisal whereby a number of participatory workshops and consultations were organised. The researcher himself facilitated the participatory workshops and consultations with the identified stakeholders in order to come up with the possible causes of poor vegetable production and feasible solution. The World Bank (2004) defines

participatory monitoring and evaluation as the approach that involves stakeholders such as the project beneficiaries, staff, and donors and community in the design and implementation of the project as opposed to the conventional approach. The methods and procedures employed in completion of each steps of this project have been discussed under results and discussion.

RESULTS AND DISCUSSION

Stakeholder and Situation Analysis

The planning of a development project, or any other type of development intervention, starts with an analysis of the situation and identification of the stakeholders. The purpose of situation analysis was to identify the needs, interests, priorities and resources of the stakeholders, all the way to the final beneficiaries, and to assess the different possibilities for improving on the existing situation (World Bank. 1997). The analysis begins with general and specific background studies and identification of the stakeholders. Stakeholders (and beneficiaries) are individuals or groups with a direct, significant and specific stake or interest in a given territory or set of natural resources and, thus, in a proposed project. A stakeholder analysis identifies all primary and secondary stakeholders who have a vested interest in the problems with which the project is concerned about. The goal of stakeholder analysis is to develop a strategic view of the human and institutional situation, and the relationship between the different stakeholders and the objectives identified. Stakeholder analysis is a continuing process that should engage different groups, as issues, activities, and agendas evolve (Gawler, M., 2005). The full participation of stakeholders in both the design and implementation of project is a key to their success. Stakeholder participation is essential for sustainability of the project; generates a sense of ownership (if initiated early in the design process); provides opportunities for learning for both the project team and for the stakeholders themselves and; builds capacity and leads to responsibility.

The identification of stakeholders' process starts from a dialogue among the stakeholders. The stakeholders together state the problems. Analysis brings

together the different opinions and views on the problem and their possible solutions. Analysis proceeds to a more detailed assessment of objectives and of the project purpose. Alternative strategies are evaluated in the light of social development. It is a joint exercise carried out by the key stakeholders. The situation of any proposed project needs to be analysed and questions are to be answered such as what are the general areas of concern, or themes, that the project will focus on?, what is the project aiming to achieve?, at what spatial levels will the project focus, in terms of subject (broad/macro to specific/micro) and or geography (local to global)?, what political, socio-economic, technological and biophysical environment will the project operate within?, who are the major stakeholders?, how will stakeholders be involved in the process of design, implementation, monitoring, evaluation and reporting?, who is working on the issues already? What are they doing?, what is the niche of the project?, who will implement the project?, what is the intended duration of the project?, what is the anticipated level of funding? , who will fund the project?

In this study, participatory and brain storming exercise was adopted to identify the stakeholders of the project and situation analysis. The stakeholder's analysis identified the stakeholders which included college management, agriculture teachers, non agriculture teachers, parents, students, gardener, non-teaching staff and grounds workers. The possible answers to important questions for situation analysis were obtained.

Problem Analysis

Following the stakeholder analysis, a problem analysis identifies all problems related to the main issue and ranks them hierarchically. The analysis, usually a "brainstorm" exercise, identifies issues and problems that are of priority to the stakeholders identified and therefore, all the stakeholders identified should contribute to this analysis. Brainstorming techniques are used to identify the main problem. Before the brainstorming exercise commences it is important that the facilitator explain the process and the stakeholders agree on some rules for brainstorming. The two most common difficulties that arise during the problem

analysis are inadequate problem specification, and the statement of the absent solutions. Inadequate problem specification occurs when the detail of the formulation is insufficient, so that it does not communicate the true nature of the problem. Absent solutions are problem statements that describe the absence of a desired situation, rather than accurately describing the actual problem. The danger with absent solutions is that they risk biasing the intervention towards that solution. For each absent solution, the facilitator asks: "If this solution were delivered, what problem would be solved?" Absent solutions may not an issue at the very bottom of the problem tree, as they identify what means are needed to address the problem above. In problem analysis of this project, actual problem (Poor vegetable production) causes were many as discussed with participants and, were taking into consideration while narrowing down to find a feasible and practical solution (shade net) to reduce the problem identified the was very clear. Once problems and issues have been identified, cause-effect relationships are established between these issues to form or develop a "problem tree" diagram for the project. Taking the raw information generated from the stakeholder-driven problem identification, the problems are ordered in an organized, hierarchical fashion flowing from causes (bottom) to effects (top). The problem tree is developed by moving problems from the clusters of problems on the wall and by adding new problems that emerge as the tree is developed. Problems can be moved up or down the tree as required. The tree should end up with one main problem and a series of lower order problems that branch out below the main problem. The easiest way to develop the problem tree is to begin with a 'starter' problem and progressively add the other listed problems to the tree. It does not really matter which problem is chosen as the starter problem but it is best if it is a problem that participants agree is of major importance. The problem tree is constructed by selecting a problem from the list and relating this problem to the starter problem using the cause-effect rationale (Davidson, 2000) described below:

- If the problem is a cause of the starter problem it is placed below the starter problem;
- If the problem is an effect of the starter problem it goes above;

• If it is neither a cause nor effect it goes at the same level.

Problem analysis, objectives analysis, and the subsequent steps in project design were carried out through participatory workshops with an experienced planner and facilitator. The researcher himself facilitated a number of participatory workshops and consultations with the identified stakeholders and concluded that the main problem is poor vegetable production in the school garden. Based on the main problem, other related problems or causes contributing to the main problem such as "damage caused by birds" and "damage caused by sun burn" were identified and thus a problem tree was developed (Figure 1).

Objectives Analysis

The objectives analysis follows the problem analysis. It is the positive mirror image of the problem tree, and describes the desired situation following completion of the project, for example in five years time. It illustrates this desired situation as a hierarchy of means-to-end relationships in an objectives tree diagram, which is derived directly from the problem tree. The objectives tree provides the basis for determining the project's hierarchy of objectives, which will eventually be used to build the project's logical framework. As with the problem analysis described above, the objectives analysis process should be conducted as a participatory exercise with all stakeholders concerned. The process of analysing the objectives begins by simply converting the negative states of the Problem tree. The objective tree developed for the proposed project is presented in Figure 2.

Strategy Analysis (Scoping)

The strategy analysis involves clustering objectives and examines the feasibility of different interventions (ITAD, 1996). The main objective becomes the project purpose and the lower order objectives become the outputs or results and activities. ITAD (1996) state … "the final stage of the analysis phase involves the selection of a strategy to achieve the desired results. The strategy comprises the clusters of objectives to be included in the project. In addition to examining the

logic, strategy analysis also looks at feasibility of different interventions. This may mean that the focus of the project shifts, therefore once the strategy has been selected, the project purpose and overall objectives are finalised."

The strategy analysis for the proposed project is presented in Figure 3. In the strategy analysis, those objectives identified in the objectives tree diagram (which were much more complex than the one illustrated above) are clustered in terms of their commonality of purpose according to lower order objectives (which would become project activities and outputs) and higher order objectives (which would become project targets and goals). Some of these strategies (clusters) will fall within the capacities of the project stakeholders, and potentially may be included in the project. Others will clearly fall outside the capabilities of project stakeholders, and will thereby be outside the remit of the project. The objectives outside the scope of the project will become the basis for defining the project assumptions or pre-conditions for project implementation. Once the different possible strategies have been clustered, the group decides on one overall project goal – the central objective at the heart of the project.

The process of making choices should be carried out in a very methodical way, giving due consideration to the ends/means relationship in the objectives tree (IUCN, 1997).In the process of scoping, different possible strategies contributing to a higher-level objective are identified, as illustrated schematically in Figure 3. Of all the strategies identified in the objectives tree, at least one will be chosen as a strategy for the proposed intervention and will be the project for the implementation. The choice of one or more strategies should be made after the project goal or target has been decided. To select the project strategy (or strategies), the group collectively identifies possible criteria for including a given strategy or objective as part of the project intervention. Criteria may include: available budget, significance of the implementation, likelihood of success, period of time to be covered, capacity of institution to achieve the objectives outlined, etc.

After considering all the criteria of selecting a suitable strategy to solve the problems of damage by sunburn and damage by birds, it was found fit that the

construction of a net shade can be the best strategy (scooping) to reduce sunburn as well as damage by birds to the vegetables which can improve the vegetable production. Therefore, this project was formulated to design and implement net shade in order to improve vegetable production.

Log Frame Analysis

The logical framework approach (LFA) has come to play a central role in the planning and management of development and aid interventions over the last years. The logical framework approach provides a set of design tools that, when applied creatively, can be used for planning, designing, implementing, monitoring, and evaluating projects. Logframes give a structured, logical approach to setting priorities, and determining the intended purpose and results of a project. Used correctly, logframes can provide a sound mechanism for developing a project concept into a comprehensive project design. Logical frameworks also lay the basis for activity scheduling, budgeting, and later for evaluating the effectiveness, efficiency, and relevance of a project (Glawler, M., 2005). ITAD (1996) suggest that 'the logframe approach remains a powerful management tool for analysis of project design'. This is the most widely used approach (Crawford and Bryce, 2003) and therefore logical framework approach was used in this study. The logical framework approach shows the relationship of inputs, processes, outputs, outcomes and goals of the project plus underlying assumptions (Crawford and Bryce, 2003). This relationship called as logical framework matrix (log frame). In other words, a Log Frame Matrix provides information on goal, purpose, objectively verifiable indicators (OVI), mean of verification (MOV) and assumptions of the project. The prepared Log Frame Matrix of the project is presented in Table 1.

Scheduling

It is a process of preparing and assigning time frame to complete various activities on the project. Processes or activities to be done on the project are tracked with aid of a project schedule or project timeline. At regular intervals actual schedule of activities done is compared with the planned schedule to

determine whether the project is within schedule or over schedule (Crawford and Bryce, 2003). The Gantt chart and PERT Chart are two popular tools to be used for scheduling. In this project, Gantt chart has been employed for scheduling purpose and presented in Table 2.

Budgeting

Budgeting is a process of estimating the cost incurred in the proposed project. In this specific project, there are number of activities (from planning of net shade construction to record keeping). Most of the activities involved (except construction of shade net) in the project were carried by the agriculture teachers. Therefore, the salary paid to agriculture teachers was not included in budget. The agriculture teachers were paid salaries as full time employees and therefore, there was no need for re-budgeting for their expenses. In other words, a partial budgeting was done for this project which included the estimated expenses for the activities of acquiring material for net shading; construction of net shade; planting materials and chemical; irrigation water and; labour. The prepared budget has been presented in Table 3.

SWOT Analysis

SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is widely used as a tool for exploring the constraints and opportunities of a proposed project. It can be used to test the completeness of the set goal. Strengths and weakness refers to those strengths and weaknesses within the project. Opportunities and threats refer to the opportunities for and the threats to the project achieving the goal. The SWOT analysis is provided in Table 4.

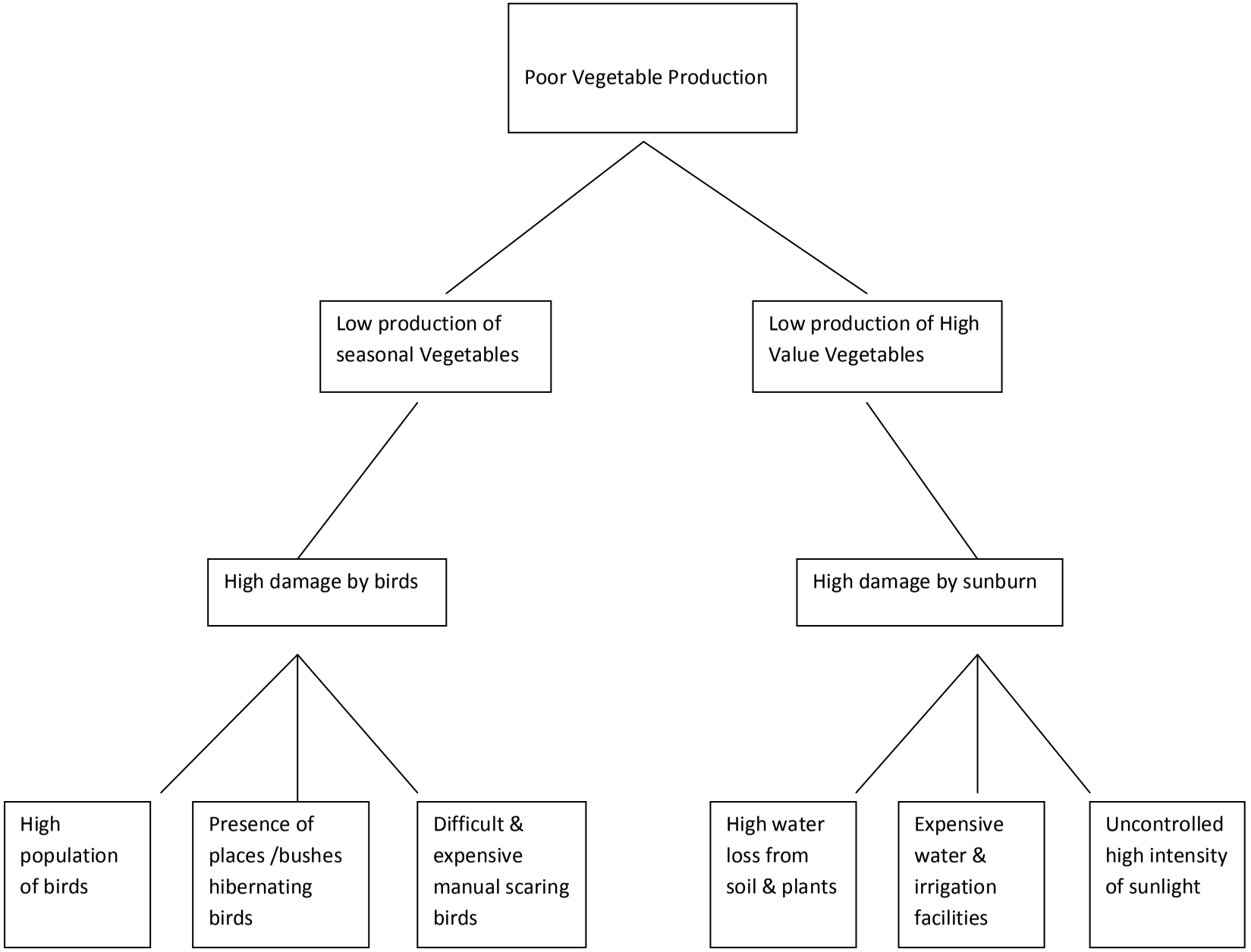

Fig 1: The Problem Tree

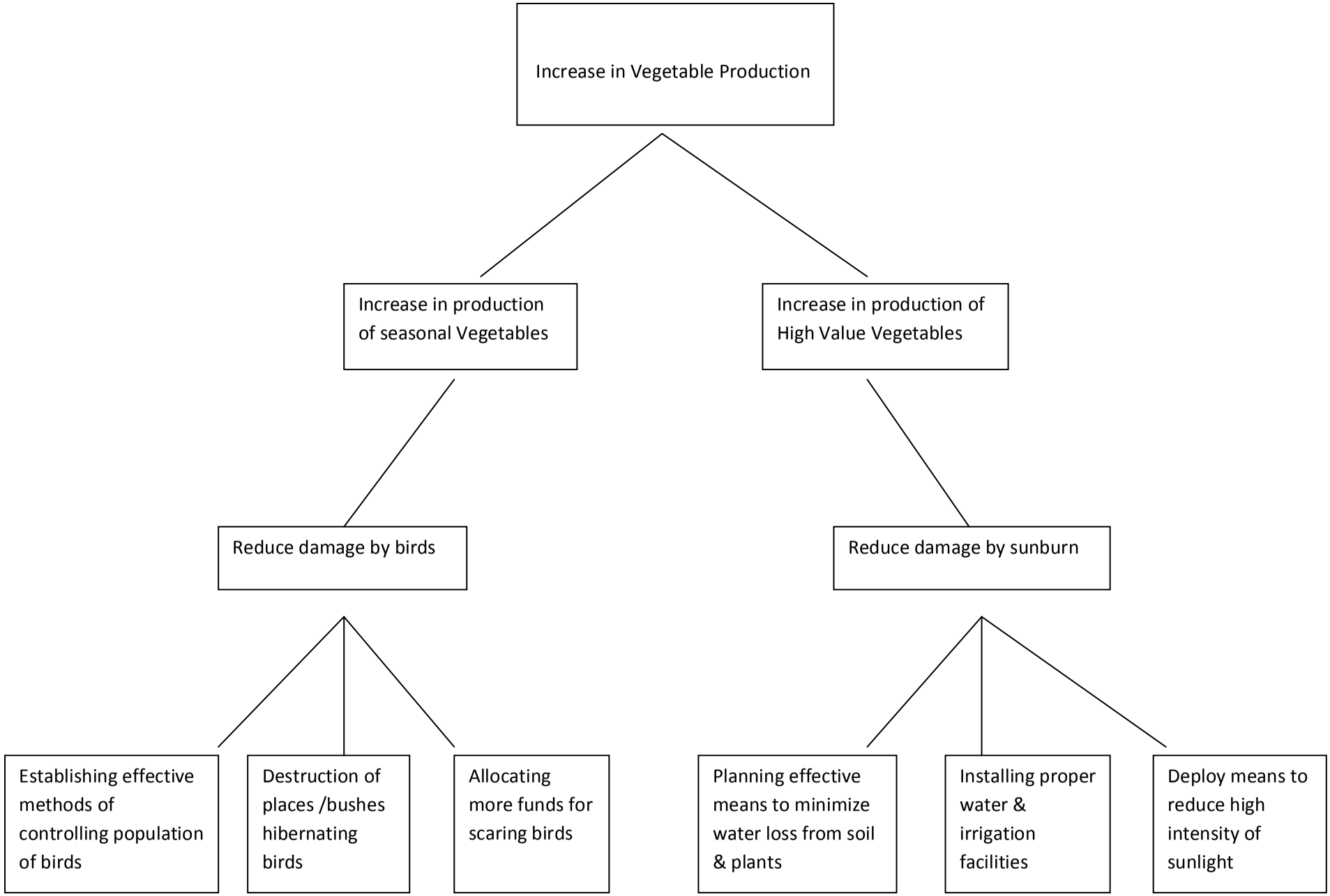

Fig 2: The Objective Tree

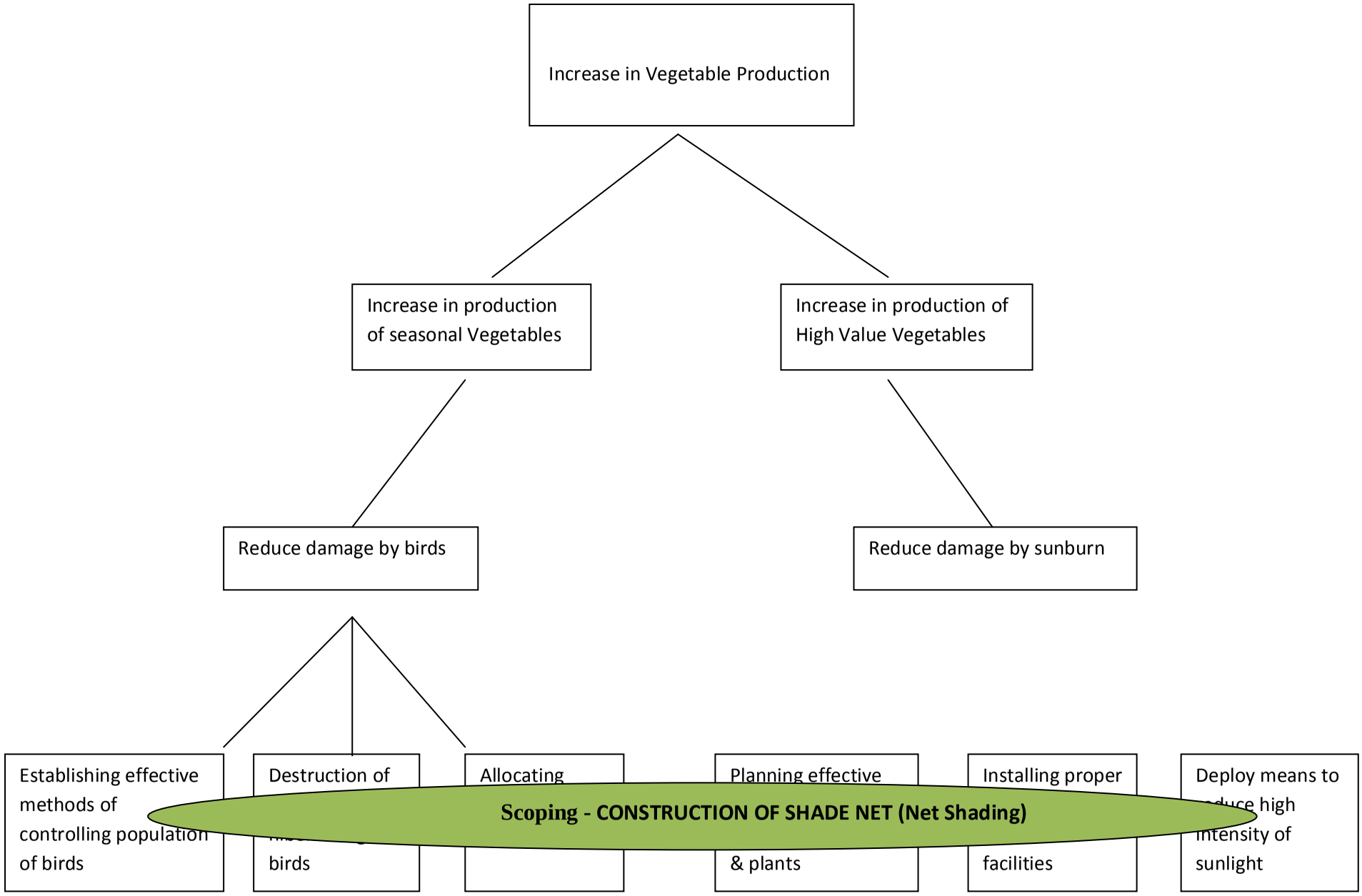

Fig 3: Project Strategic Analysis (Scoping)

Table 1: Log frame matrix of the project

Objectives	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal: 1. Increase in production of seasonal vegetables 2. Increase in production of high value vegetables	1. Summer vegetable crop production increased by 50% by the end of the plan period. 2. High value vegetable crop production increased by 50% by the end of the plan period.	1. Vegetable production records 2. Vegetable production records	1. Management adopt the project 2. All inputs required are available. 3. School community buy the produce
Purpose: 1. To increase the vegetable production 2. To demonstrate shade net unit to students as practicals 3. To generate additional income	Increase in vegetable production by 100% per annum Demonstrate practice of shade net at least to 100 students Increase in income from vegetables sale by 50%	1. Vegetable production records 2. Demonstration record 3. Income record	Proper cultural and management practices are enforced Effective demonstration plan is implemented
Outputs: 1. Net shade constructed	1. Constructed net shade by end of February 2012	1. Physical inspection 2. Production records	Any desirous natural calamity does not happen

2. Increased production of vegetables 3. Additional income generated	2. Production of vegetables increase by 100% 2. Income from production of vegetables increase by 50%	3. Income record	
Activities: 1. Planning for net shading construction 2. Acquiring material for net shading 3. Construction of net shade 4. Planning of crop production 5. Planting of vegetable crops 6. Management of planted crops 7. Harvesting and marketing 8. Conduction of demonstration 9. Record keeping	1. Prepared plan for net shading 2. Acquired material for net shading 3. Constructed net shade 4. Prepared crop production plan 5. Planted vegetable crops 6. Planted crops managed 7. Demonstration conducted 8. Records kept	1. Annual reports 2. Physical visits 3. Records	1. All materials/resources required for shade net are available. 2. Management is willing in shade net development

Table 2: Gantt chart for the project

ACTIVITY	Year 2012												Mile stone/Task	Responsible person/authority
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
10. Planning for net shading construction													Net shading plan prepared	Agric. Teachers
11. Acquiring material for net shading													Net shading material acquired	Agric. Teachers/ College Management
12. Construction of net shade													Net shade constructed	Agric. Teachers/ College Management/Contractor
13. Planning of crops production													Crop production plan prepared	Agric. Teachers
14. Planting of vegetable crops													Plantation of crops done	Agric. Teachers/ Worker
15. Management of crops planted													Crops managed	Agric. Teachers/ Worker
16. Harvesting and Marketing													Harvesting & marketing done	Agric. Teachers/ Worker
17. Conduction of demonstration													Demonstrations conducted	Agric. Teachers/Students
18. Record keeping													Records maintained	Agric. Teachers/ Worker

Note: The shaded part indicated the period/months for conduction of activities. The activities 4, 5, 6, 7, 8 and 9 will continue to the next year 2013.

Table 3: Project budgeting

Activity	Item	Unit Price	Total cost
Acquiring net shading material	*A. Cost of material:*		
	i) Net 80% thickness (300 meters)	P35 per meter	P10500
	ii) Gum poles (50)	P75 per pole	P3750
	iii) Galvanized wire (20 Kg)	P 70 per kg	P1400
	iii) Binding wire (2mm 20 kg)	P75 per kg per 5 kg	P300
	iv) cement 4 bags	P 55 per bag	P220
	v) concrete $2m^3$	P75 per m^3	P150
	v)i Nails (4 inch 2kg)	P 40 per kg	P80
	B. Transportation charges	P600 per load	P600
Construction of net shade	Net shade construction	P 4000 contract	P 4000
Acquiring of seeds, fertilizers, chemicals and packing material	*A. Cost of seeds*		
	Tomato 100gm	P50 per container	P 50
	Rape 100gm	P23 per container	P23
	Spinach 100gm	P 30 per container	P30
	Onion 100gm	P75 per container	P75
	Cabbage (sprouts)	P 23 per packet	P23
	Lettuce	P 32 per packet	P32
	Coriander	P 10 per packet	P20
	2:3:2 Fartilizer 50 Kg one bag	P 400 per bag	P400
	Malasol 750 ml	P 120 per pack	P120
	Packing material		P 150
	B. Transportation charges		P25
Labour charges		P 700 per month	P 8400
Water charges		P400 per month	P 4800
		Total Budget	P34548

Table 4: SWOT Analysis of the project

STRENGTHS	**WEAKNESSES**
1.Availability of skilled professionals to implement and supervise the project 2. Sustainable production of vegetables through the year 3. Full financial support by the college management	1. Unavailability of a full time gardener
OPPORTUNITIES	**THREATS**
1. Scope of expansion of the net shaded area 2. Project will also be used for practical and project purposes by the students 3. Other organisations can be exposed to the project and motivate them to plan for such project in their institution	1. Theft of the vegetables grown 2. Rats may damage the net and needs proper control 3. High temperatures and scorching sunlight may reduce the life of net

Project appraisal

The appraisal is an internal examination of the merits and feasibility of the project (Gawler, M., 2005). The appraisal is always done before project is implemented. The appraisal was carried out. The project has well defined problem, quantifiable and achievable objectives. It will be economic viable project which will ensure not only improvement in vegetable production but also improve the quality of vegetables as well as increase in income. It is very practical in its implementation as all the resources such as finance, water, place and human powers are available and provided by the college management. There are qualified agriculture teacher to implement the project and guide and supervise the Gardner for its effective implementation and monitoring. It is hope that this project will not only achieve its set objectives well but also will educate and inspire other for its multiplication at other institutions as well as vegetable farms in Botswana.

Project Implementation

The project (net shade) construction completed in March 2012 and therefore, the project was implemented in the school garden at Livingstone Kolobeng College,

Gaborone, Botswana (Southern Africa). An experienced constructor was employed to construct the net shade in an area measuring 30×15 meter. After construction was over, a proper layout of the plots inside the shaded area was done by the agriculture teachers and the gardener. A proper crop plan was prepared so as to ensure the full utilization of the net shade. Vegetable crops grown included rape, mustard, spinach, Asian spinach, tomatoes, lettuce, spring onions, onions, coriander, egg plants, green pepper, hot pepper, turnips, radish, mint and cabbage (sprouts) were planted. The pictures from 1-36 are the evidence of the implementation of the project (Appendix 1).

Monitoring and Impact Evaluation

There are generally considered to be clear and important differences between 'monitoring' and 'impact evaluation' (or 'impact assessment'), both of which have a place in a project. 'Monitoring is continuous assessment both of the functioning of the project activities in the context of implementation schedules and of the use of project inputs by targeted populations in the context of design expectations (Casley and Kumar, 1987). Monitoring refers to the process of systematic collection and analysis of information during the implementation of a project. It is aimed at improving the efficiency and effectiveness of an implemented project. It also provides base for evaluation of the project. Monitoring is an internal project activity and is an essential part of good managerial practice, and therefore an integral part of day-to-day management' (Casley and Kumar, 1987). Evaluation is the systematic collection of information about activities, characteristics, and outcomes of projects to make judgments about the project, improve effectiveness, and/or inform decisions about future programming (Patton, 1987). Evaluation (impact assessment) is a periodic assessment of the relevance, performance, efficiency and impact of the project in the context of its stated objectives. The full exercise of the evaluation function requires supplementing the project management information system with data from impact studies that may be designed and executed outside the project management system itself' (Casley and Kumar, 1987). Evaluation compares the impact of a project against the set objectives of a project. The appropriate

evaluation methodology varies from project to project and depends on project objectives, evaluation questions, data availability, cost, time constraints, and other limitations therefore; evaluator must carefully explore the methodological options in designing the study, with an aim to produce the most robust results possible. The evidence from the 'best practice' evaluations reviewed for this study highlights that the choice of impact evaluation methodologies is not mutually exclusive (Baker,1999)). Indeed, stronger evaluations often combine methods to ensure robustness and to provide for contingencies in implementation. Joining a 'with and without' approach with a 'before and after' approach that uses baseline and follow-up data is one combination strongly recommended from a methodological perspective (Subbarao et al 1999; Casley and Kumar, 1988). Having baseline data available allows evaluators to compare the changes after project implementation and prepare for a robust impact evaluation.

In this study, participatory approach, logical framework and quantitative method of data collection were adopted. Before and after approach was adopted to assess the impact of the project Monitoring and Evaluation plan of this study involved three points as most of the projects i) Establishing verifiable and impact indicators, ii) Setting up system to collect relevant data and, iii) Methods of data analysis. All these three major points in monitoring and evaluation of this project were prepared carefully to realise the actual impact of the project implemented. The impact indicators are one of the crucial aspects of a project. They are quantitative and qualitative variables that provide a simple and reliable means to measure achievement, reflect changes connected to an intervention, or help assess the performance of an organisation and project against the stated target (Rajalahti, R. et al, 2005). The impact indicators for this project were quantifiable and based on the project objectives. The impact indicators of this projects included increase in seasonal vegetable production, increase in high value vegetable production, increase in total vegetable production, increase in income from vegetable production and, increase in the number of demonstration conducted. The participatory evaluation approach adopted for this project was Goal Based which focuses on the assessing

achievement of goals and objectives of the project. A Goal Based evaluation attempted to find if the set goals and objectives by using before and after approach and therefore, by comparing base line data (before implementation) and the data after implementation (post implementation) of the project. The base line data and after implementation data for each of the impact indicator were collected using proper record keeping system. The impact of the project was assessed by comparing the determined baseline values and the target values for each impact indicator. The monitoring and evaluation plan and the impact of the project (results) are presented in Table 5.

The impact evaluation has been discussed by comparing the data on target objectives before and after implementation of the project. The production of seasonal vegetable production increased from 204 kg to 544 kg increased by 340 kg (167%) against set target of 50%. The production of high value vegetable production increased from 364 kg to 947 kg increased by 583kg (160%) against set target of 50%. The improvement in production of seasonal vegetables and high value vegetable increased total production of vegetables from 568 kg to 1491 kg and boosted to 162% increase in total vegetable production. Because of the increase in vegetable production, the income generated from the sale of vegetable produced was increased by P3026 (103%) against a target of 100%. The increase in the vegetable production and returns is similar found in the previous studies conducted by Mangmang, 2002; Palada and Ali, 2007; Neave et al, 2011 and, Ramasamy, 2011). The net shade project has not only increased the vegetable production but also improved the quality of vegetable as well. There was no shade net in the school before this project therefore it was not possible to demonstrate and have any practical activity with the students doing agriculture subject. After the projects have been implemented about 100 students doing agriculture have been demonstrated the shade net and its benefits in improving the income, quantity and quality of vegetables.

Table 5: Monitoring and Evaluation Plan and Impact of the Project

Objectives	Verifiable Indicator	Method/means of Data collection	Method of data analysis	Post project implementation data on target objective	Base line data on target objective	Impact of the project
1. To increase in production of seasonal vegetables	50% increase in seasonal Vegetable production (in Kg)	Seasonal vegetable production records	Descriptive statistics such as total, average and percentage	544	204	167 % increase in seasonal vegetable production
2. To increase in production of High Value Vegetables	50% increase in High Value Vegetable production (Kg)	High value vegetable production records	Descriptive statistics such as total, average and percentage	947	364	160 % increase in high value vegetable production
3. To increase in the total vegetable production	Increase in vegetable production by 100% per annum (Kg)	Vegetable production records	Descriptive statistics such as total, average and percentage	1491	568	162% increase in total vegetable production
4. To generate additional income	Increase in income from vegetable production by 100% per annum (P)	Vegetable Income records	Descriptive statistics such as total, average and percentage	5966	2940	103% increase in total income from vegetable production
5. To create and provide a demonstration and practical unit for students	Increase100% in number of demonstration	Demonstration attendance records	Descriptive statistics such as total, average and percentage	105	00	100% increase in demonstrations and practicals conducted

At the time of writing (mid-June 2012), P1 was approximately equivalent to US$ 0.12. P refers to Pula and is the currency of Botswana.

CONCLUSION AND RECOMMENDATIONS

The designing, implementation and impact evaluation of the net shade project has shown positive and encouraging results. The project has achieved all the set objectives. The project has been able to protect the vegetable crops from sunburn and birds. This fact is supported and reflected by the impact evaluation. The impact evaluation has indicated an improvement not only in the quantity of vegetables produced but their quality. The total vegetable production has increased by 162% which resulted in an increase in the income by 103%. The demonstration of this protective production technique (shade net) provided a practical experience for the students and also, motivated them to use net shade at their homes and farms.

It is recommended that this or similar shade net structure should be constructed and demonstrated to the parents, farmers and other organisation by organising agricultural shows so that the people involved can realise that net shade is a perfect and sustainable solution to improve the vegetable production and income in Botswana. The Ministry of Agriculture can take initiative of constructing a couple of net shade structure as pilot projects across the country where the stakeholders can be exposed to such structures.

ACKNOWLEDGEMENT

The author would like to acknowledge the support from the Management of Livingstone Kolobeng College, Gaborone, Botswana (Southern Africa) for providing the opportunity to be part of this developmental project. This paper is based on an assignment for a course 'Project Design and Evaluation' which the author had during his study for Master of Education (Research and Evaluation) at University of Botswana.

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APPENDIX 1: Pictures evidencing the implementation of the net shade project

Figure 1:Fixing poles with cement and concreate

Figure 2: Fixed poles to support net

Figure 3: Fixed Net on the poles

Figure 4: Layout of the plots inside the net area

Figure 5: Panormaic view of net shade after plantation

Figure 6: Panormic view of net shade before plantation

Figure 7: Students performing practical activities

Figure 8: Flowering climber green beans

Figure 9: Rape crop in plots

Figure 10: Spinach crop in Plots

Figure 11: Plots with cabbage (sprouts)

Figure 12: Plots with lettuce

Figure 13: Layout of plots in three blocks of plots

Figure 14: Plots with green pepper

Figure 15: Plots view from shade net entrance

Figure 16: Performance of turnips and radish

Figure 17: Plot with Asian spinach

Figure 18: Mint herb plants inside net shade

Figure 19: Closer view of green peppers

Figure 20: Closer view of Coriander herb

Figure 21: View of different crops facing college building

Figure 22: View of lettuce plots facing college building

Figure 23: Longer view of plots of rape crop

Figure 24: Intercropping coriander with green pepper

Figure 25: Onion seedlings and spring onions

Figure 26: Seedlings of rape ready for transplantation

Figure 27: Plots with blooming tomato plants

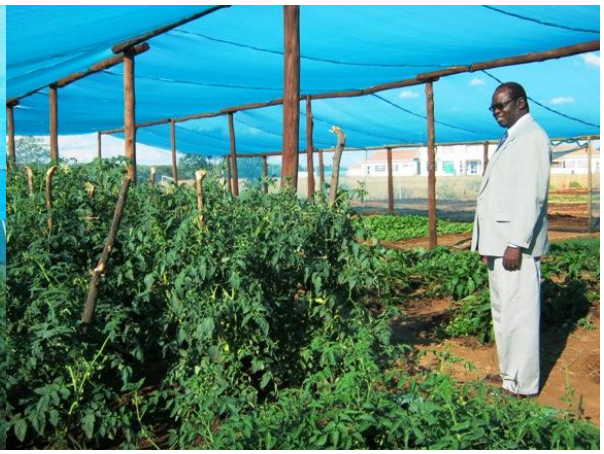

Figure 28: College administrator admiring tomato crop

Figure 29: Hot Pepper plant with fruits

Figure 30: Egg plants bearing eggs fruits

Figure 31: Harvested tomato fruits

Figure 32: Harvested roots of Turnips

Figure 33: Harvested roots of Radish

Figure 34: Spring onions ready for Harvesting

Figure 35: Mixed coloured spinach

Figure 36: Three different types of Lettuce