Blood Electrolytes Changes after Burn Injury

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Abstract

Sixty five patients (35 males and 30 females, aged 16 - 45 years, average 30 years) admitted to the Burn unit of a regional burn centre, National Orthopeadic Hospital, Enugu, Nigeria, were investigated for serum levels of sodium, potassium, chloride, bicarbonate, urea and creatinine. The patients were divided into four groups according to percent total body surface area (%TBSA) affected by the burn. Healthy individuals (16 -45 years) who had no burn were used as control. Blood collection started on the first day of admission at 2-day intervals for 3weeks and weekly for the next 9 weeks. The results showed biochemical anomalies following burn Injury. The patients demonstrated significant (P< 0.05) decreases in the serum concentration of sodium, chloride and bicarbonate. Patients with 15-34% TBSA showed slight decreases while patients with 75% TBSA burn and above had marked decreases. In this group, potassium level was elevated form a control range of 4.0±0.5 mmol/l to 5.50±0.45 mmol/l and the mean urea concentration was 44±20mg/100ml compared with mean control value of 27.5±12.5 mg/100ml. Serum creatinine was increased to 1.7±0.7mg/100ml from a control value of 1.05±0.35mg/100ml. Serum sodium decreased to 131.5±2.5mmol/l from 141±4.0mmol/l, chloride decreased to 92±5.0mmol/l

from 102.5±7.5mmol/l and bicarbonate decreased to 20.5+ 2.5mmol/l from a control value of 25.0±3.0mmol/l. Aggressive monitoring of electrolytes is necessary for proper assessment of the extent of the initial disturbances and the response to therapy.
Keywords: *Burn, Electrolytes, Anomalies*

INTRODUCTION

Burn Injury initiates the greatest dysregulation of homeostasis of any injury and is an example of a general pathological condition that although primarily located in one site produces a response in apparently unrelated metabolic systems [1]. The determination of the serum level of a single electrolyte is insufficient for an overall evaluation of a patient's metabolic state. When one wishes to determine the serum level of any electrolyte the whole series should be ordered [3,4]. Electrolytes of clinical importance include sodium, potassium, chloride and co_2 content as bicarbonate. In addition to electrolytes determination, it is extremely necessary that the blood urea nitrogen (BUN) and creatinine which are products of metabolism be determined as well [5,6]. This serves two purposes, first, serum electrolytes values have one implication in the presence of an elevated BUN level whereas when the BUN level is normal the implication changes. Also the BUN is a relatively good indication of the patients overall water metabolism and hydration status which has a pronounced effect on the different electrolytes. Secondly, if replacement therapy must be instituted it is essential to know kidney function [7,8,9].

METHOD

Sixty five patients admitted to the Burn unit of National Orthopaedic Hospital, Enugu, Nigeria, were investigated for the serum levels of sodium, potassium, chloride, bicarbonate, urea and creatinine. The patients were divided into four groups using the Lund and Browder chart for estimating severity of burn wound. Group A had 15-34 percent total body surface area (% TBSA) affected; Group B, 35-54%TBSA; Group C,55 - 74%TBSA and Group D,75%TBSA and above . Blood collection started on the day of admission at 2-day intervals for 3weeks and weekly for the next 9weeks. Serum was separated from blood cells immediately after clotting by centrifugation at 3000 revolution per minute for 5 minutes using

a temperature-regulated centrifuge (CRU 5000, Damon IIEC Division, London).Healthy individuals without burn matched for age and sex were used as control. Samples were analyzed on the day of collection. Serum sodium and potassium were determined by Flame emission photometer and serum chloride, bicarbonate, urea and creatinine by autoanalyser methods (Chemwell, USA).

Statistical Analysis

Two way analysis of variance analysis (ANOVA) and correlation coefficient were carried out for each group of patients. Results were expressed as percentage or as mean± standard deviation. Statistical significance was set at a p-value <0.05.

RESULTS

Burns cause excessive loss of body fluids and so of plasma volume. In the acute phase of the burn Injury, the results were statistically significant ($p<0.05$). We observed decreases in the serum concentration of sodium, chloride and bicarbonate according to percent total body surface area affected by burn especially in patients with 75%TBSA burn and above. (Table 1). In this group sodium decreased from a control value of 141±4.0 mmol/l to 131.0±2.0 mmol/l, chloride decreased from 102.5±7.5 mmol/l to 89.0±2.0 mmol/l while serum bicarbonate decreased to 19.0±1.0 mmol/l from 25.0±3.0 mmol/l. We noted a 21% elevation in potassium and 37.5% increase in serum urea in patients with severe burn. The elevated creatinine correlated with urea values. Five patients with 55%TBSA burn and above had remarkable urea values in the range of 170mg/100ml, sodium in the range of 127mmol/l and potassium of 7.5mmol/l.

WEEKS	UREA (mg/100ml)	CREATININE (mg/100ml)	K^+ (mmol/L)	Na^+ (mmol/L)	CL^- (mmol/L)	HC_{03}^- (mmol/L)
3 Weeks	44±20	1.7±0.7	5.5±0.45	131.5±2.5	92±5.0	20.5±2.5
6 Weeks	39±17	1.5±0.6	4.5±0.7	134±4.0	95±5.0	21.5±1.5
9 Weeks	34±14	1.3±0.5	4.35±0.65	137±3.0	98±6.0	22.5±1.5
12 Weeks	30±12.5	1.15±0.45	4.2±0.6	138±3.5	100±7.0	24±2.0
Control	27.5±12.5	1.05±0.35	4.0±0.5	141±4.0	102.5±7.5	25.0±3.0

Table 1: Mean value changes of electrolytes after burn injury.

Serum levels of urea, creatinine and potassium were significantly elevated up to the 9th week post burn while serum levels of sodium, chloride and bicarbonate were decreased in the 3rd and 6th week.

DISCUSSION

Significant ($p<0.05$) anomalies were noted in the concentrations of the biochemical parameters analyzed. Serum sodium, chloride and bicarbonate levels were low. This is because water passes from the intracellular to the extracellular fluid mainly to within the interstitial space. The ability to excrete a sodium load is diminished leading to overall retention of sodium and chloride but as the retention of water is generally greater than that of sodium the plasma sodium and chloride concentrations tend to fall slightly. The serum potassium concentration increased in this study because excess potassium is released from damaged cells faster than it can be removed in the urine. Hyponatramia might be explained either by a shift of sodium ions into cells in excess of water or by a net shift of water out of cells or by both phenomena occuring at the same time in different tissues. A general cellular gain of sodium ion in excess of potassium ion from the cell seems the most likely explanation [10,11,12].

Mean urea concentration during the period of study was 44±20mg/dl against a control value of 27.5±12.5mg/dl while mean serum creatinine level was 1.7+0.7mg/dl compared with mean control value of 1.05±0.35 mg/dl. Serum urea and creatinine levels were higher in males that in females. The accelerated breakdown of muscle towards mobilization of amino acids combined with any fall in the glomerular filtration rate results in a rise in serum urea and creatinine. [13]. It was generally observed that severity of the burn injury tallied with percentage increase or decrease in the serum concentration of the biochemical parameters analyzed. In addition anion gap difference and urea/creatinine ratio showed good correlation with percent total body surface area affected. Serum levels of urea, creatinine and potassium remained significantly altered till the 9th week postburn, though the initial changes observed abated gradually. The remarkable results obtained from some patients included elevations in serum potassium concentration to 7.5mmol/l, urea of 170mg/dl while serum sodium decreased to 127 mmol/l. This may be due to decreased effective blood circulation with the reduced plasma in this condition leading to low blood pressure which ultimately reduced the effective filtration rate of the glomeruli [14,15].

The clinician may need to seek the help of the biochemistry department to monitor the severity of the initial disturbances and the effectiveness of the response especially if there are complications and whether or not these are modified by therapy. Such information and advice are often essential for the care of the patient. This is because once the Injury is larger than 10-15% total body surface area in size, the physiological impact is no longer local but affects distant and systemic mechanism [16].

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Study on the Implication of Land Use Expansion and Land Cover Change around Yankari Game Reserve in Relation to Wildlife Habitat Degradation

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Abstract
The research investigated the various types of land use practices around 5km outside the Yankari Game Reserve boundary and the extent of land cover changes and degradation of biological resources inside there serve for the period of 30years. Landsat imageries of the reserve from 1984 to 2014 were used for change detection using Maximum Likelihood Algorism Method. The socio economic characteristics of the inhabitant surrounding the reserve were investigated using questionnaire. The results indicated that the major land use practice around the reserve boundary include among others farming, livestock husbandry, settlement, mining, fishing and hunting. While percentage changes in land cover classes inside the reserve between 1984 and 2014 were: bare ground (+36.67%), gallery forest (-3.02%), open savanna (+2.58%), rock outcrop (+9.39%), build-up area (+4.39%), woodland savanna (-43.49%). Changes within 5km outside the reserve between 1984 and 2014 were: bare ground (+3.01%), gallery forest (-48.99%), open savanna (+8.45%), rock outcrop (-30.88%), built-up area (-1.19%) and woodland Savanna (-7.56.). Significant difference (p< 0.05) occurred in both inside and within 5km outside the reserve in changes of land cover classes between 1984 and 2014. The incidences of decimation of resources over the years in the study area were driven by anthropogenic factors, engineered principally by poverty and low literacy level. The study recommended that, the support zone communities should be empowered economically, socially and politically by adding value to their culture and tradition and selling them to tourists, conservation education, illiteracy classes and visit to successful conservation areas as well as seminars and workshops relating conservation and policies issues among others.

Keywords: *Land Use, Degradation, Habitat, Vegetation and Poverty*

INTRODUCTION

Protected Area (PA) refers to any area of land and/or sea specially dedicated for the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal and other effective means. The basic role of a PA is to separate elements of biodiversity from processes that threaten their existence in the wild. Globally there are some 30,000 Protected Areas (PAs) covering about 12.8 million km^2 which amount to 9.5% of the planet land area (World Commission on Protected Area WCPA 2000). In Nigeria today there are over 504 PAs covering about 12.8% of the country's total land area, harboring more than 5,000 species of plants and over 22,094 species of animals including insects, 889 species of birds and 1,489 species of microorganisms (Federal Environmental Protection Agency FEPA Annual Report, 1999). These records placed Nigeria 8^{th} and 11^{th} highest African country in terms of flora and fauna diversity respectively (Comesky, 2000).

Due to increase in population growth and growing demands for improved livelihood condition, there is a corresponding pressure on PAs and their surrounding environment which threatens the validity of most PAs globally as well as endangering the health and wellbeing of the biological resources in them. Damschen *et al.* (2006), Fischer (2007) and Fahrig (2003) described this as an act where natural cover has been converted into pasture, crop land, or urban use, which in turn affects biodiversity through both habitat loss and fragmentation and in some cases alteration of community composition (Pidgeon *et al.*, 2007). Other effects include limiting species ranges (Schulte *et al.*, 2005), restricting animal dispersal and migration (Damschen *et al.*, 2006; Eigenbrod *et al.*, 2008; Fahrig, 2003) and facilitating invasion by non-native species (Gavier *et al.*, 2010; Predick, 2008).

Studies have revealed that land use intensities around PAs soon after their establishment has the effect of altering ecological stability, through reduction in their effective size and fragmentation of the system (IUCN, 2010). In a study conducted by Sanderson *et al.* (2002), entitled "measuring

human footprint on biological resources", it was observed that humans have modified over 83% of the Earth's land surface due to land-use. Thus, changes in land-use practices, and more specifically, conversion of land from more natural conditions to less natural conditions is one of the main threats to biological diversity (Fischer, 2007; Vitousek, 1997). Intensifying land uses around PAs often threaten their ecological integrity and effectiveness of PAs as a conservation tool (Joppa *et al.,* 2008).

In densely populated Mesoamerica for example, the expansion of agriculture, mining and logging, infrastructural projects, land speculation, urban, residential and tourism development threaten many protected areas (Gude *et al.,* 2007). Land is becoming a scarce resource due to immense agricultural and demographic pressures. Haruna *et al.* (2010) have noted that rapidly increasing human populations and expanding agricultural activities have brought about extensive landuse changes throughout the world. According to the projection by the United Nations, the world population is expected to increase to 9 billion people by 2050. Most of the additional 2.3 billion people will add to the population of developing countries, which are projected to rise from 5.6 billion in 2009 to 7.9 billion in 2050.

The projection on global population however, the developing countries are expected to have more pressure on demand for arable land, pastoral, and/or settlement use. The remaining fringes of lands around most protected areas (buffer zones) would be liable for such demand. Therefore, understanding the level of landuse and landuse changes around protected areas at different spatial levels is important to have a better understanding of the effect of human pressures on protected areas. It is equally important because species relate to landscape in different ways. Therefore, it is important to understand land-use change at different scales that correspond to the range of scales at which species relate to environment. In developing countries like Nigeria, land use types include farming, grazing, mining, hunting, use of forest as sacred groves and settlement emanating from migration due to political, social and religious conflicts as well as

ecological degradations. The advent of protected area system meant that some land area used for the above purposes became converted to conservation areas. Unfortunately, there were no commensurate benefits coming from the conservation projects as expected by people. The problem became compounded with increasing population over the years. The growing population meant increase in demand for more land to produce more food, to build more houses and for other contingent needs.

Hence, the emergence of pressure on protected areas. The pressure in the recent years has transformed into illegal grazing, hunting, mining, fishing and encroachment of agricultural land into conservation areas. Marguba (2002) observed that in spite of the enormous benefits derivable from conservation areas the negative attitudes of local residents toward the protected areas have persisted. These phenomena therefore forced many of the Nigerian Game Reserves and Forest Reserves to exist only on paper due to increasing pressure of land uses while many were degazatted and converted to farmlands, settlements and or grazing reserves. The few that can be seen, Yankari Game Reserve inclusive are becoming islands of forest between human settlements and farmlands and have continued to receive such pressure.

METHOD OF DATA COLLECTION

The Study Area

The research was conducted at Yankari Game Reserve (YGR) and 5km around the reserve boundary in Alkaleri Local Government Area, 105km from the state capital (Bauchi). The reserve is located at Latitude 09° 45.131′ N and Longitude 010° 30.746′ E. It was established as Game Reserve in 1955 and upgraded to a National Park status in 1991 under the management of the National Parks Service. In 2006, the Bauchi State Government reclaimed it from the Federal Government, thus, reverting its status from Yankari National Park to Yankari Game Reserve. The reserve falls entirely within Bauchi State and occupies a total land area of 2,244.10 km^2. It covers Duguri, Pali and Gwana Districts of Alkaleri LGA (Green, 1987).

Data Source

The data used for this study was Landsat TM imagery of Bauchi and environ for 1984, 1994, 2004 and 2014, obtained from center for Remote Sensing, Jos. The imageries were taken during the rainy seasons of precisely the month of May of the following years 1984, 1994, 2004 and 2014. In addition a geo-referenced land use Map of Bauchi was used to carve out and code the extent of the study area using the upper and lower limit coordinates of the Yankari Game Reserve with the aid of ArcMap version 9.2 and AutoCAT- 2002 software. The areas include the core area of the reserve and 5km around the perimeter of the reserve.

Equipment and Software Used

During the field survey and laboratory analysis, the equipment used included a four wheel drive vehicle, motor cycle and Etrex Germin high sensitivity Global Positioning System (GPS) for geo-referencing all the communities located around 5km of the Game Reserve perimeter as well as other land forms. In addition, Panasonic camcorder camera 32 pixil at 37mm optical zoom strength was used. The soft wares used included Microsoft excel for importation of coordinates of various communities and land features into ArcGIS software. Microsoft Word, IDIRISI 32, and Integrated Land and Water Information System (ILWIS) were used for laboratory analysis.

Steps Used in Image Processing

The images used for this study were processed in the laboratory using the following steps;-

Step 1: Creation of Map List

The map list of 1984, 1994, 2004 and 2014 of Yankari Game Reserve and 5km imageries were created with the aid of ILWIS software. In order to have sets of roster maps with the same geo-referenced parameters, imagery of 1984 were paired with 1994 and 1994 was paired with 2004, similarly 2004 was paired with 2014. The idea of doing this was to ensure correlations

between possible changes of succeeding and preceding years when paired. The same process was repeated for 5km in 1984, 1994, 2004 and 2014 Map list.

Step 2: Image Importation

Selected bands of the imageries acquired (Landsat MT) of 1984,1994, 2004 and 2014 bands 2, 3, and 4 were imported from the computer folder where they were stored on ILWIS software for the classification of the land cover of the study area. Accordingly band 2, 3, and 4 were selected for this classification because land features such as vegetation, bare ground, rock outcrop and water bodies are best displayed in blue, green, and red wavelengths of the visible spectrum.

Step 3: Sub Mapping

This was achieved using Arc Map version 9.2 and Auto CAD, 2002 software. Top left and bottom right coordinates of the geo-referenced map of the study area 634370.135mN, 694699.124mN and 633574.238mE, 691356.356mE were used to map out the area of interest in the images (Bands 2, 3, and 4). This technique was used in order to reduce the data quantity and to analyse the desirable areas of interest.

Step 4: Color Composite

The color composite of 1984, 1994, 2004 and 2014 images were formed by combining the three sub mapped raster bands (Band 4-Red, Band 3-Green and Band 2- Blue for Landsat cover changes that occurred in the reserve and 5km outside the reserve, the total area covered by the YGR boundary was extended to 5km beyond the perimeter of the reserve using the same Arc Map version 9.2 Software TM) into single maps. This is done in order to give the image a clear visual impression of the true picture on ground instead of displaying one band at a time which its interpretation would require highly specialize technology.

Step 5: Definition of Domain

In order to classify the image produced by the various land cover features the Domain class has to be determined, coded and used as variables for the image classification. These include Bare Ground (BG), Galary Forest (GF), Open Savanna (OS), Rock Outcrop (RO), Build up area (Wikki Camp) (WC) and Woodland Savanna (WL).

Step 6: Pixel Training/Creation of Sample Set

Sample set for 1984, 1994, 2004, and 2014 images were created using the land cover class code from the domain. Each of the respective images was classified by selecting and assigning names (Code) to group of training pixels that are supposed to represent a known feature on the ground and have similar spectral value in the map. This is so achieved with the aid of the coordinates of a particular feature obtained from the field using GPS.

Step 7: Image Classification

At this stage the study area was classified into bare ground, gallery forest, open savanna, rock outcrop, and build up area (Wikki Camp) as well as woodland savanna for both images, except the 5km study area outside the reserve. Wikki Camp was not considered as sample set, because bare ground outside the reserve tends to dominate the buildup area (villages). This is so, because of the fact that the buildup areas could not be captured by the satellite due to its low resolution (Landsat TM). Hence, they became overshadowed by the bare ground because Landsat TM satellite captured only land features that are larger than 30m. After the completion of the classification of the four (4) images (1984, 1994, 2004 and 2014), the classified images were exported via windows Bitmap (BMP) to IDRISI 32 software for post classification comparisons and statistical analysis

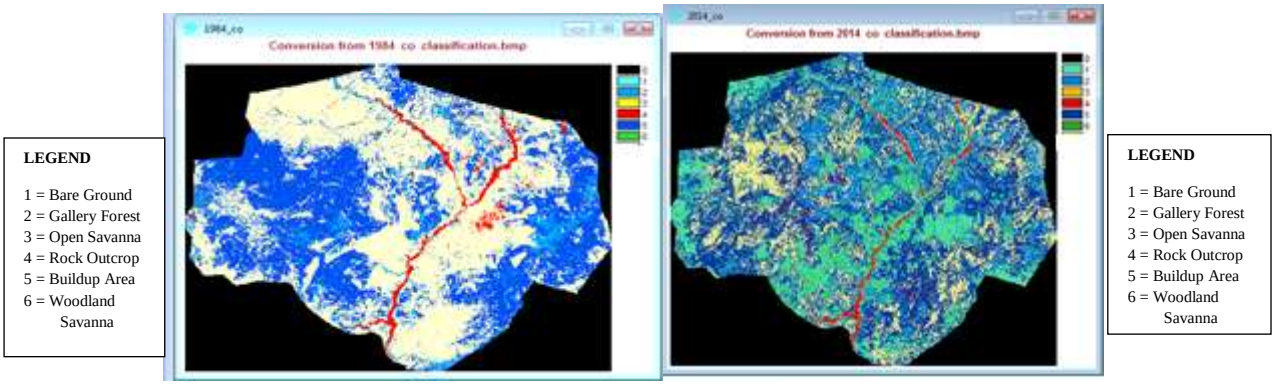
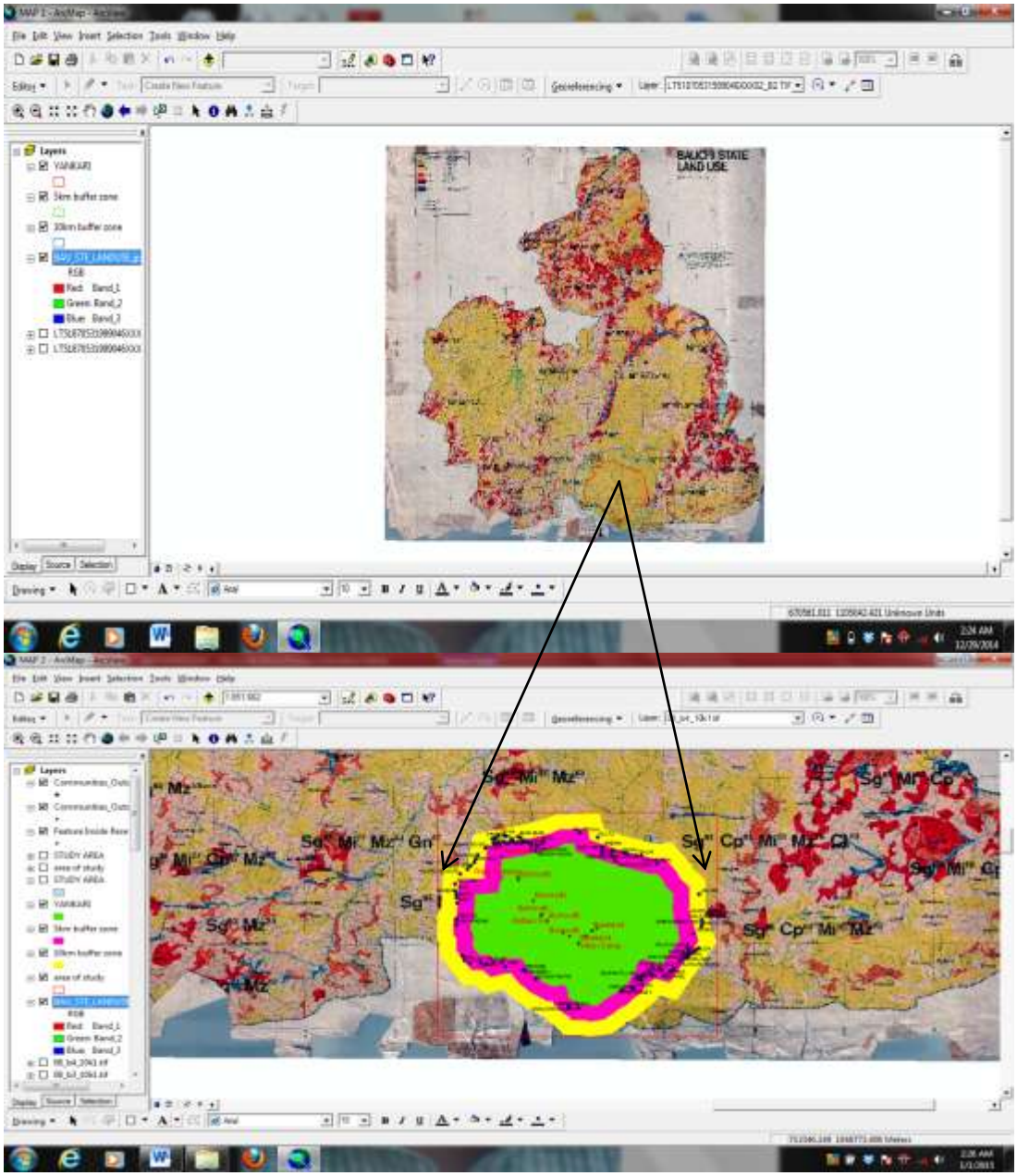


Figure 1: May 1984 Classified Land Cover Image of Yankari Game Reserve

Figure 2: May 2014 Classified Land Cover Image of Yankari Game Reserve



CO- Reser 5km around reserve per meter 10km around the perimeter

B: Figure 2: Land Use Map of Bauchi State, 1999 and Extent of Study Area Covered.
Source: Source: Min. of Land and Survey Bauchi 2014; lab analysis 2015

RESULT AND DISCUSSION

Six land cover classes were identified in YGR for the purpose of this study. They include, bare ground, gallery forest (riverine vegetation), open savanna, rock outcrop, build-up areas and woodland savanna. The finding of the supervised classification techniques of 1984 and 1994 imageries indicated land cover classes changes within the reserve with the exception of the bare ground. Build-up areas were not captured, either due to situation that prevailed at the time of capture or because their 'areas' were below 30m in radius. Gallery forest, open savanna and rock outcrop increased in size while woodland savanna decreased in size. These findings are in line with those of Gajere (2001) and Shuaibu (2012)

The cross tabulation analysis (CTA) result indicated that although an increase occurred in gallery forest, the increase was not significant. The open savanna which traversed the entire reserve adjoining all other land cover classes indicated both gains and losses. Parts of the open savanna were converted to gallery forest, woodland savanna and rock outcrop between 1984 and 1994. Some patches of the open savanna remained unchanged over the period under review. The woodland savanna which also adjoins other land cover classes lost parts of its cover to gallery forest, open savanna and the rock outcrop. The variation in changes in land cover classes may not be unconnected with the location of the land cover class in the reserve and its accessibility and vulnerability to human activities. These observations agreed with those of Shuaibu (2012) who indicated that land cover change in Mubi North was attributed to increased human activities.

The resilience of the bare ground may not be unconnected with improper use of fire for the ecosystem combined with inadequate protection against overgrazing by the reserve management during the period under review. The conversion of patches of the open savanna and woodland savanna to the gallery forest can be explained by the fact that the management of the YGR (during the period under review) ensured that the gallery forest and the adjoining land were protected against both early and late fire regimes in

the reserve. Besides, protection was also ensured by the management against lopping, grazing and fuel wood/ timber exploitation. The high water table in the area could also have aided the growth of the vegetation into a gallery forest ecosystem. Similarly, the effects of protection as observed with the open savanna changing to gallery forest is in agreement with the report of Geerling, (1973a) and Ola-Adam (1996) for the vegetation utilization of YGR and Olokomeji forest reserve.

The loss of patches of the Open Savanna to Woodland Savanna may also be attributed to the practice of controlled burning (early fire regime) and protection against lopping and grazing. The loss of patches of Woodland Savanna to Open Savanna may be connected with its attractiveness to the pastoralists due to heavy presence of leguminous trees such as *Afzelia africana, Anogeisus leocarpu*and*, Prosopis africana* which are highly palatable to livestock (cattle sheep and goat). The pastoralists tend to defy all management measures (as observed during the study) to access the Woodlands, where they engage in both lopping and indiscriminate burning. The results are loss of vigor by trees and susceptibility to infection by diseases, and consequently death. Besides fire, fuel wood collection and timber exploitation thrive in the Woodlands. These observations agree with those of Gajere (2001) Ibrahim (2005) and Mohammed (2009).
The result of the study also revealed that patches of the open savanna and that of the woodland savanna were lost to rock outcrop during the 1984-1994 period. Rainfall data over the same period suggest that long period or spells of drought may be contributing factor, coupled with wildfire, over grazing and erosion. The observation agrees with that of Mohammed (2014) and Ibrahim (2005).

Results of the supervised classification techniques of 1994 to 2004 as well as the Cross Tabulation Analysis (CTA) also revealed that there was no consistent change in Land Cover Class (LCC) during the period under review. The results suggest that the threat factors and their pattern of operations and influences on the land cover classes during the period 1984 to 1994 remained the same over the period 1984-2004. However, there were

exceptional cases. These are in respect of emergence of bare ground in gallery forest and build-up areas in some land cover classes. In respect of emergence of bare ground in the gallery forest, interaction with the surrounding communities revealed that increase in agricultural activities aided by agricultural mechanization, which took place within 5km outside the reserve led to loss of woody vegetation from a large area. The result was an unprecedented run-off following heavy rain falls into the tributaries that feed the Gaji, Yashi and Yuli Rivers that are situated within the basin of the reserve. This led to the over flow of the river banks and consequently the flooding of the basin (Gaji river) at the center of the reserve which contains the gallery forest. The repeat of this incidence over the years may probably be caused of the death of the trees leaving the area affected as bare ground. Similar close observations were reported by Gajere (2001) Ibrahim (2005).

Gallery forest lost to woodland savanna, open savanna, rock outcrop and build-up areas. Woodland savanna lost to gallery forest, open savanna, and bare ground. Build-up areas, rock outcrop and open savanna lost to gallery forest, woodland savanna, bare ground, rock outcrop and buildup area. Rock outcrop lost to open savanna, and to build-up area.

Furthermore, observations during the study, indicated management failure to repair the jeep tracks which serves as fire breaks that prevent annual fire (control fire) from crossing into the gallery forest. This situation may also have contributed to loss of vegetation along the riverine forest. Besides, restriction of elephants to the riverine forest during the dry season for their food which are mostly browsers, have been observed to account for a great loss of woody plant species in the gallery forest. The Gaji river valley is the only source of dry season water. Hence, enormous pressure is received from the elephants and many other large mammals in the riverine forest during the dry season. Trees are eaten up, trampled and killed by the elephants, thus exposing some portions of the gallery forest to bare ground. These observations agree with Green (1986). Geerling (1973a) and

Marshall (1985a) reported that elephant population in the reserve constituted a threat to the reserve ecosystem.

Another serious ecological upset that developed during the period under review was the build-up area. Gallery forest, woodland savanna, open savanna and rock outcrop, all lost portions of their land to build-up area. Investigation through ground truthing during the study revealed that expansion of the Wikki Spring for sun bathing area as well as development of spring beech for recreation activities resulted in the expansion of build-up area. The excavations along the riverine forest for building constructions, and development of wikki Camp also contributed to increase build-up area in the reserve during 1994-2004 periods. The implication is the reduction in wildlife habitat in the reserve.

Findings from the supervised classification techniques of 2004 to 2014 and the cross tabulation analysis (CTA) of the data further revealed variation in changes in land cover classes. The results indicated losses from gallery forest, woodland savanna, and open savanna to bare ground; build-up area and rock outcrop suggest the prevalence of such factors like flood, uncontrolled fire, over grazing, lopping, logging, and fuel wood collection and elephant activities. Conversely, the change from; open savanna to woodland savanna and gallery forest; bare ground and rock outcrop to open savanna suggest adequate management practices in terms of burning practices and protection against over grazing, lopping, logging and fuel wood collection as well as prevalence of good weather during 1984-2004 period. The observations agree with the report of Environ-Consult (2000; 2006) on Kaiji Lake National Park and Ola-Adams (1996) and on Olokomeji forest reserve that control burning is responsible for the maintenance of the ecological integrity of wildlife habitat.

Findings from the Supervised Classification Techniques (SCT) and Cross Tabulation Analysis (CTA) of land cover class's data obtained within 5km outside the reserve indicated similar pattern and trend as those obtained within the reserve. This is because; like those obtained within the

reserve, there were no consistent changes in the land cover classes from 1984-1994; 1994-2004; 2004-2014. However, when the area (size) of bare ground, build-up area, and rock outcrop within and outside of the reserve were proportionately compared, it was found that those outside the reserve were significantly ($p<0.05$) higher. Similarly, comparison of gallery forest, woodland savanna and open savanna between those within the reserve and those outside the reserve indicated significantly ($p<0.05$) higher values for those within the reserve. The results therefore suggest that the anthropogenic factors are the major factors impacting negatively on the biological resources of the reserve. This observation agrees with those of Akosim *et al.,* (2004) and Yaduma (2012) for Kaiji Lake National Park and Gashaka Gumti's National Park respectively.

Table1: Changes in Land Cover Classes inside Yankari Game Reserve between May 1984 and May1994 (%)

Cover Class	Category	Area in M^2 1984	Area in M^2 1994	Difference	% change
Bare Ground	1*	-	-	-	-
Gallery Forest	2	66,050	69,412	+3,362	+0.99
Open Savanna	3	936,590	1,028,700	+92,110	+74.18
Rock Outcrop	4	153,630	187,716	+3,408,6	+10.16
(Buildup Area)*	5*	-	-	-	-
Woodland Savanna	6	1,363,860	1,234,302	-129,558	-14.68

*Land cover class not larger than 30m during 1984/94.
Source: Field Survey 2014

Table 2: Cross Tabulation Analysis of Land Cover Classes between May 1984 and May 1994 inside Yankari Game Reserve.

S/N	Cover class	Change in square	Meter 1984 | 1994	
1	Gallery Forest	65,973	2 | 2	Gallery Forest in 1994
2	Open Savanna	815	3 | 2	
3	Woodland Savanna	2,644	6 | 2	
4	Open Savanna	905,099	3 | 3	Open Savanna in 1994
7	Rock Outcrop	639	4 | 3	
8	Woodland Savanna	122,970	6 | 3	
9	Open Savanna	29,673	3 | 4	Rock Outcrop in 1994
10	Rock Outcrop	152,999	4 | 4	
11	Woodland Savanna	5,044	6 | 4	
12	Gallery Forest	77	2 | 6	Woodland Savanna in 1994
13	Open Savanna	1,003	3 | 6	
14	Woodland Savanna	1,233,222	6 | 6	

Legend: 1= Bare ground, 2= Gallery Forest, 3= Open Savanna, 4= Rock Outcrop, 5= Buildup Area, 6= Woodland Savanna.
Source: Field Survey 2014

Table 3: Changes in Land Cover Classes inside Yankari Game Reserve between May, 1994 and May 2004 (%)

Cover Class	**Category**	**Area in M^2 1994**	**Area in M^2 2004**	**Difference**	**% change**
Bare Land	1	-	360, 123	+360,123	+40.11
Gallery Forest	2	69,412	67, 273	-2, 139	-0.24
Open Savanna	3	1, 028, 700	1, 215, 617	+186, 917	+20.82
Rock Outcrop	4	187, 7 16	250, 513	+62,797	+6.99
(Build-up Area)*	5	-	55, 897	+55, 897	+6.23
Woodland Savanna	6	1, 234,302	1,468, 604	+234, 302	+26.09

*Landcover Class not Larger than 30m during the Study Period.
Source: Field Survey 2014

Table 4: Cross Tabulation Analysis of Land Cover Classes between 1994 and 2004 inside Yankari Game Reserve.

S/N	Cover class	Change in Square Meter	1994/2004	
1.	Gallery Forest	9,828	2 | 1	Bare Ground in 2004
2.	Open Savanna	100,361	3 | 1	
3.	Rock Outcrop	22,564	4 | 1	
4.	Woodland Savanna	217,370	6 | 1	
5.	Gallery Forest	28,790	2 | 2	Gallery Forest in 2004
6.	Open Savanna	18,605	3 | 2	
7.	Rock Outcrop	5,353	4 | 2	
8.	Woodland Savanna	14,525	6 | 2	
9.	Gallery Forest	7,499	2 | 3	Open Savanna in 2004
10.	Woodland Savanna	502,006	3 | 3	
11.	Rock Outcrop	77,295	4 | 3	
12.	Woodland Savanna	628,817	6 | 3	
13.	Gallery Forest	4,907	2 | 4	Rock Outcrop in 2004
14.	Open Savanna	105,685	3 | 4	
15.	Rock Outcrop	34,544	4 | 4	
16.	Woodland Savanna	105,377	6 | 4	
17.	Gallery Forest	548	2 | 5	Build-up Area in2004
18.	Open Savanna	19,558	3 | 5	
19.	Rock Outcrop	282	4 | 5	
20.	Woodland Savanna	32,966	6 | 5	
21.	Gallery Forest	7,840	2 | 6	Woodland Savanna in2004
22.	Open Savanna	282,485	3 | 6	
23.	Rock Outcrop	45,135	4 | 6	
24.	Woodland Savanna	235,247	6 | 6	

1= Bare Ground, 2= Gallery Forest (riverine vegetation), 3= Open Savanna, 4=Rock Outcrop, 5=Build-up Area, 6= Woodland SavannaSource: Field Survey 2014

Table 5: Land Cover Classes changes insideYankari Game Reserve between May 2004 and May, 2014 (%).

Cover Class	Category	Area in m^2 2004	Area in m^2 2014	Difference	% Change
Bare Ground	1	360,123	567,741	+207,618	+14.12
Gallery Forest	2	67,273	54,741	-47, 968	-3.26
Open Savanna	3	1,215,617	976,529	-239,088	-16.27
Rock Outcrop	4	250,513	299,062	+48,549	+3.30
Build-up Area	5	55,897	68,031	+12,134	+0.83
Woodland Savanna	6	1,468,604	554,026	-914,578	-62.21

Source: Field Survey 2014

Table 6: Cross Tabulation Analysis of Land Cover Classes between 2004 and 2014 inside Yankari Game Reserve

S/N	Cover class	Change in Square meter	2004/2014		
1.	Bare Ground	309,079	1	1	Changed to Bare Ground in 2014
2.	Gallery Forest	114	2	1	
3.	Open Savanna	252,733	3	1	
4.	Rock Outcrop	1,913	4	1	
5.	Build-up Area	3	5	1	
6.	Woodland Savanna	3,899	6	1	
7.	Bare Land	2,152	1	2	Changed to Gallery Forest in 2014
8.	Gallery Forest	50,259	2	2	
9.	Open Savanna	2,228	3	2	
10.	Woodland Savanna	102	6	2	
11.	Bare Land	14,739	1	3	Changed to Open Savanna in 2014
12.	Gallery Forest	16,544	2	3	
13.	Open Savanna	858,845	3	3	
14.	Rock Outcrop	33,009	4	3	
15.	Woodland Savanna	53,392	6	3	
16.	Bare Land	30,382	1	4	Changed to Rock Outcrop in 2014
17.	Open Savanna	60,177	3	4	
18.	Rock Outcrop	208,503	4	4	
19.	Bare Ground	1,542	1	5	Changed to Build-up Area in 2014
20.	Open Savanna	10,595	3	5	
21.	Build-up Area	55,894	5	5	
22.	Bare Ground	2,229	1	6	Changed to Woodland Savanna in 2014
23.	Gallery Forest	356	2	6	
24.	Open Savanna	31,039	3	6	
25.	Rock Outcrop	7,088	4	6	
26.	Woodland Savanna	513,314	6	6	

Cover Class	Category	Area in M^2 1984	Area in M^2 2014	D	% change
Bare Ground	1	-	567741	567741	+36.67
Gallery Forest	2	66,050	19305	46745	-3.02
Open Savanna	3	936,590	976,529	39939	+2.58
Rock Outcrop	4	153,630	299,062	145432	+9.39
Build-up Area	5	-	68031	68031	+4.39
Woodland Savanna	6	1,363,860	683584	680276	-43.94

Table 7: Land Cover Classes changes of Yankari Game Reserve between 1984 and 2014(%)
Source: Field Survey 2014.

Legend: 1= Bare land, 2= Gallery Forest (riverine vegetation), 3=Open Savanna, 4=Rock outcrop, 5=Build-up area, 6=Woodland Savanna Source: Field Survey 2014
Source: Center for Remote Sensing Jos, 2015 and Laboratory Work 2015

Table 8: Changes in Land Cover Classes in Yankari Game Reserve between 1984 and 2014

Degree of Freedom (n-1)	T-tabulated	T-calculated	Standard error of the mean
5	2.57	5.19	.177

Note: 5.19 value is significant at $p<0.05$ level.
Source: Field Survey, 2014

Table 9: Land Cover Classes changes in5km outside the Yankari Game Reserve Boundary between May 1984 and May, 1994 (%).

Cover Class	Category	Area in M^2 1984	Area in M^2 1994	Difference	% Change
Bare Ground	1	1,610,643	1,722,712	+112,069	+23.32
Gallery Forest	2	1,462,801	1,486,420	+23,619	+4.91
Open Savanna	3	798,143	953,966	+155,823	+32.43
Rock Outcrop	4	1,211,312	1,182,890	-28,422	-5.91
Build-up Area	5	110,111	141,179	+31,068	+6.46
Woodland Savanna	6	788,000	658,442	-129,558	-26.96

Source: Field Survey 2014

Table 10: Cross Tabulation Analysis of Land Cover Classes between 1984 and 1994 5km outside the Yankari Game Reserve Boundary

S/N	Cover Class	Change in Square Meter	1984/1994	
1.	Bare Ground	1,610,643	1 | 1	
2.	Gallery Forest	1,528,746	1 | 2	Bare Ground in 1994
3.	Open Savanna	27,086	2 | 2	
4.	Gallery Forest	105	1 | 3	
5.	Open savanna	74,628	2 | 3	Gallery Forest in 1994
6.	Buildup Area	1	4 | 3	
7.	Open Savanna	5,664	2 | 4	
8.	Rock Outcrop	1,364,942	3 | 4	Open Savanna in 1994
9.	Open Savanna	31,069	2 | 5	
10.	Buildup Area	110,110	4 | 5	Build-up Area in 1994
11.	Woodland Savanna	575,860	5 | 6	Woodland Savanna in 1994

Legend: 0=Bare Ground, 1=Gallery Forest, 2=Open Savanna, 3=Rock Outcrop, 4=Build-up Area, 5=Woodland Savanna. Source: Field Survey 2014

Table 11: Land Cover Classes changes in Yankari Game Reserve between May 1994 and May, 2004 within 5km outside the Reserve (%)

Cover Class	Category	Area in M^2 1994	Area in M^2 2004	Difference	% Change
Bare Ground	1	1,722,712	1,691,977	-30,735	-1.18
Gallery Forest	2	1,486,420	50,076	-1,436,344	-55.07
Open Savanna	3	953,966	1,044,415	+90,449	+3.47
Rock Outcrop	4	1,182,890	291,398	-891,492	-34.18
Build-up Area	5	141,179	74,345	-66,834	-2.56
Woodland Savanna	6	658,442	566,000	-92,442	-3.54

Source: Field Survey 2014

Table 12: Land Cover Classes changes in Yankari Game Reserve between May 2004 and May, 2014 5km outside the Reserve (%)

Cover Class	Category	Area in M2 2004	Area in M2 2014	Difference	% Change
Bare Ground	1	1,691,977	1,700,361	+8, 384	+30.33
Gallery Forest	2	50,076	36,237	-13, 839	-50.06
Open Savanna	3	1,044,415	1,049,819	+5404	+19.54
Rock Outcrop	4	291,398	291,398	+0.00	0.00
Build-up Area	5	74,345	74,396	+15	+0.07
Woodland Area	6	566,000	566,000	+0.00	+0.00

Source: Field Survey 2014

Table 13: Cross Tabulation Analysis of Land Cover Classes between 1994 and 2004 5km outside the Boundary of Yankari Game Reserve (YGR)

S/N	Cover Class	Change in Square Meter	1994/2004	
12.	Bare Ground	826,604	1 | 1	Turn to Bare Ground in 2004
13.	Gallery Forest	26,143	2 | 1	
14.	Open Savanna	480,157	3 | 1	
15.	Rock Outcrop	59,298	4 | 1	
16.	Woodland Savanna	299,775	6 | 1	
17.	Bare Ground	13,521	1 | 2	Turn to Gallery Forest
18.	Gallery Forest	26,551	2 | 2	
19.	Open Savanna	7,061	3 | 2	
20.	Rock Outcrop	1,689	4 | 2	
21.	Woodland Savanna	1,254	6 | 2	
22.	Bare Ground	413,028	1 | 3	Turn to Open Savanna in 2004
23.	Gallery Forest	9,408	2 | 3	
24.	Open Savanna	437,464	3 | 3	
25.	Rock Outcrop	31,835	4 | 3	
26.	Woodland Savanna	152,679	6 | 3	
27.	Bare Ground	103,992	1 | 4	Turn to Rock Outcrop in 2004
28.	Gallery Forest	6,901	2 | 4	
29.	Open Savanna	124,859	3 | 4	
30.	Rock Outcrop	24,375	4 | 4	
31.	Woodland Savanna	31,271	6 | 4	
32.	Bare Ground	32,900	1 | 5	Turn to Build-up Area in 2004
33.	Gallery Forest	316	2 | 5	
34.	Open Savanna	22,268	3 | 5	
35.	Rock Outcrop	1,959	4 | 5	
36.	Woodland Savanna	16,902	6 | 5	
37.	Open Savanna	165,786	1 | 6	Turn to Woodland Savanna in 2004
38.	Gallery Forest	5,415	2 | 6	
39.	Open Savanna	298,797	3 | 6	
40.	Rock Outcrop	22,023	4 | 6	
41.	Build-up Area	73,979	6 | 6	

1= Bare Ground, 2=Gallery Forest, 3=Open Savanna, 4= Rock Outcrop, 5=Build-up Area, 6=Woodland Savanna.

Source: Field Survey 2014

Table 14: Cross Tabulation Analysis of Land Cover Classes between 2004 and 2014 5km outside the Boundary of Yankari Game Reserve (YGR)

S/N	Cover Class	Change in Square Meter	2004/2014	
1.	Bare Ground	1,691,243	1 | 1	Turned to Bare Ground in 2014
2.	Gallery Forest	9,113	2 | 1	
3.	Bare Ground	729	1 | 2	Turned to Gallery Forest in 2014
4.	Gallery Forest	35,492	2 | 2	
5.	Open Savanna	16	3 | 2	
6.	Gallery Forest	5,420	2 | 3	Turned to Open Savanna in 2014
7.	Open Savanna	1,044,399	3 | 3	
8.	Rock Outcrop	291,398	4 | 4	Turned to Rock Outcrop in 2014
9.	Gallery Forest	51	2 | 5	Turned to Build-up Area in 2014
10.	Build-up Area	74,345	5 | 5	
11.	Woodland Savanna	56,600	6 | 6	Turned to Woodland Savanna in 2014

1=Bare Ground, 2=Gallery Forest, 3=Open Savanna, 4=Rock Outcrop, 5=Build-up Area, 6=Woodland Savannah.

Source: Field Survey 2014

Table 15: Land Cover Classes Changes in 5km Outside Yankari Game Reserve Boundary between 1984 and 2014 (%)

Cover Class	Category	Area in M^2 1984	Area in M^2 2014	D	% change
Bare Ground	1	1, 610, 643	1, 700, 361	89718	3.01
Gallery Forest	2	1,462, 801	36, 237	-1459164	-48.99
Open Savanna	3	798, 143	1, 049, 819	251676	+8.45
Rock Outcrop	4	1, 211,312	291, 398	-919914	-30.88
Build-up Area	5	110, 111	74, 396	-35715	-1.19
Woodland Savanna	6	788, 000	566,000	-222000	-7.56

Source: Field Survey 2014

Table 16: Changes in Land Cover Classes in 5km Outside the Boundary of Yankari Game Reserve between 1984 and 2014.

DF (n-1)	T-tabulated	T-calculated	Standard error of the mean
5	2.57	7.74	.238

Note: 7.74 value is significant at $p<0.05$ level.

Source: Field Survey 2014

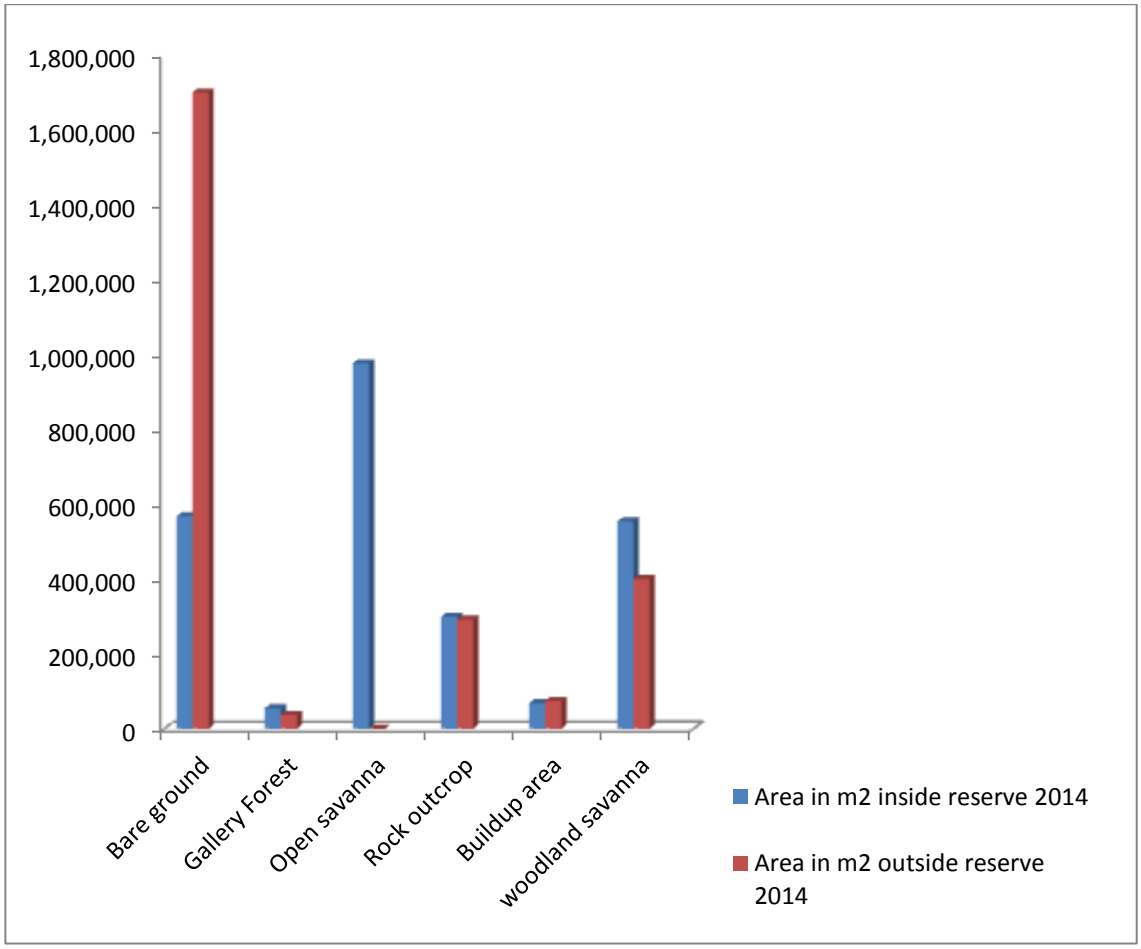


Figure 1: Proportional Area Comparison of Land Cover Classes (LCC) between Inside and 5km outside YGR Boundary in 2014.

Source: Field Survey, 2014

CONCLUSION

The finding of this study have indicated that the biological resources and their supporting systems in Yankari Game Reserve have been in a state of dynamics, maintaining predominantly negative trends over the period of thirty (30). The negative trends changes are linked to anthropogenic activities and natural environmental hazards. Poor management of the reserve also compounded the problems for over the period of about thirty years. Similarly, the result indicated an abysmal net negative change in land cover classes, with a significant reduction in Gallery forest and woodland Savanna which once provided the much needed cover and food for diverse and populous wildlife species of the reserve which have also been decimated. There is also emerging expansion of portions of bare land, Rock outcrop, buildup area and Open Savanna in places once covered by luxuriant Woodlands and Gallery forest.

The study revealed a total depletion of wildlife habitat including land and other supporting systems in the support zone communities. The investigation also revealed that over the years, there has been a net influx of migrants into the Support Zone Communities located within 5km around the reserve boundary as a result of political, social and religious conflicts as well as ecological degradation in the neighbouring states. The combined effects of these factors results in an unprecedented pressure on the resources of the reserve through livestock grazing and lopping of trees for fodder, illegal hunting, fuel wood collection, lopping and collection of stakes for fencing and roofing, collection of minor forest products, illegal fishing with dangerous chemicals, mining and aiding of wildfire in the reserve. It is the effects of these human activities combined with spells of drought and other natural hazards such as floods, pests and diseases that have decimated and degraded biological resources and their supporting systems, thus bringing them to the current status in Yankari Game reserve.

RECOMMENDATIONS

In view of the findings of this study, the following recommendations are suggested:

(1) the support zone community should be empowered economically through:

a. The establishment of community woodlot, game ranching and captive breeding, mushroom production using simple biotechnology techniques, adding values to agricultural waste for local consumption and export, and integrated agriculture involving fish farming, poultry, livestock farming and a little of arable farming.

b. Encouraging the formation of cooperative association and social groups that can access credit facilities and soft loan for making a souvenir for tourist, setting of shops and restaurant and building locally designed traditional chalets.

c. Adding value to culture and tradition of the Support Zone Communities and selling them to tourists.

d. Eliminating ignorance by empowering the support zone residents socially and politically through conservation education, organizing illiteracy classes, organizing tours to successful conservation areas as well as seminars and workshops relating conservation to policies.

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R Sarima Reanalysis of Dengue Cases in Campinas, Sao Paulo, Brazil

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Abstract
A well analyzed monthly time series of the number of dengue cases is hereby re-analyzed. A controversy regarding the most adequate SARIMA model is once again herein addressed. Monthly incidence of dengue was initially believed to follow a SARIMA $(2,1,2)x(1,1,1)_{12}$ model. Herein, analyzing the same realization of the time series by the same software R, a SARIMA $(2,1,1)x(1,1,1)_{12}$ model is found more adequate than the former model. The likelihood therefore is that the SARIMA $(2,1,2)x(1,1,1)_{12}$ model was fitted in error using R.
Keywords: *Dengue numbers, SARIMA, R, Eviews*

INTRODUCTION

Martinez *et al.* (2011) analyzed a realization of the monthly number of dengue cases from 1998 to 2008 in Campinas, State of Sao Paulo in Brazil. They chose the SARIMA$(2,1,2)x(1,1,1)_{12}$ model from a list of such models of orders: $(a,1,b)x(1,1,1)_{12}$ where (a,b) = (2,2), (2,1), (1,2), (1,1), (2,3) and (1,3). The basis of their comparison was minimum Akaike Information Criterion, AIC (Akaike, 1974). They used 2009 out-of-sample forecasts/observations comparison to buttress their argument of model adequacy.

Etuk and Ojekudo(2014) reanalyzed the same data which was published by Martinez *et al.*(2011) using Eviews software. They concluded that the model selected by the latter was not the most adequate on the same AIC grounds. They rather found the SARIMA$(2,1,1)x(1,1,1)_{12}$ model to be best. They suggested that this discrepancy could result from the software difference.

This work is a further replication of the research work. The R software which was originally used shall still be used for data analysis. The motive of this write-up is to document the observed discrepancies in the analysis of the same series by the same methods and to suggest that Martinez *et al.* (2011) may have chosen the model using R in error.

MATERIALS AND METHODS

Since this is a replication of their research, the same materials used by Martinez *et al.* (2011) were used. These include:

Data

As mentioned above, the same data as analyzed and published by Martinez *et al.* (2011) shall be analyzed. They are monthly dengue cases from 1998 to 2008 in Campinas, Sao Paulo, Brazil.

Sarima Model

Box and Jenkins (1976) defined a $SARIMA(p,d,q)x(P,D,Q)_s$ model as

$$A(L)\Phi(L^s)\nabla^d\nabla_s^D X_t = B(L)\Theta(L^s)\varepsilon_t \quad (1)$$

where $\{X_t\}$ is a time series; $A(L)$ and $\Phi(L)$ are the non-seasonal and the seasonal autoregressive operators which are polynomials in L of orders p and P, respectively; $B(L)$ and $\Theta(L)$ are the non-seasonal and the seasonal moving average operators which are polynomials in L of orders q and Q respectively; ∇ and ∇_s are the non-seasonal differencing operators defined by $\nabla=1-L$ and $\nabla_s=1-L^s$ where L is a backshift operator defined by $L^kX_t = X_{t-k}$ and s is the period of seasonality of the series; $\{\varepsilon_t\}$ is a white noise process.

Sarima modelling involves first of all the determination of the dimension of the model. The autoregressive orders p and P are suggestive by the respective non-seasonal and the seasonal cut-off lags of the partial autocorrelation function. Similarly q and Q are suggestive by the respective non-seasonal and seasonal cut-off lags of the autocorrelation functions. The seasonal period s may be naturally suggestive by a knowledge of the seasonal nature of the series. An inspection of the series

could also reveal a not-too-obvious seasonal tendency. The correlogram could also reveal a seasonal tendency. The differencing orders d and D should be used if the original series is non-stationary. Often at most two differencings (seasonal and/or non-seasonal) are enough to get rid of the non-stationary behaviour.

For model selection, the information criterion, AIC (Akaike, 1974) shall be used.

Computer Software

The 3.3.1 version of the R software shall be used (Ihaka and Gentleman, 1996).

RESULTS AND DISCUSSION

The logarithm of X_t+1 is modelled where X_t is the number of dengues at time t is modelled. The time plot is shown in Figure 1. Etuk and Ojekudo(2014) have shown that this time series is not stationary and neither are its seasonal (i.e, 12-monthly) differences. However they showed that the non-seasonal differences of its seasonal differences are stationary. This work is restricted to the chosen models of Martinez *et al.* (2011).

Table 1 shows that the SARIMA $(2,1,1)x(1,1,1)_{12}$ model is the most adequate with the least of AIC and error variance estimate. This is the second best model in the analysis of Martinez *et al.*(2011). Table 2 shows summaries of the relative orders of preferences of the models. It may be observed that the optimum model of this work was also adjudged the most adequate by Etuk and Ojekudo(2014). Therefore the model is

$$Y_t = 1.4436Y_{t-1} - 0.7070Y_{t-2} - 0.3660Y_{t-12} + \varepsilon_t - 0.8939\varepsilon_{t-1} - 0.8939\varepsilon_{t-12} \quad (2)$$

where $Y_t = \nabla\nabla_{12} \log(X_t+1)$.

Adequacy of the model (2) is not in doubt given the residual plots of Figure 2. The residuals are all non-significant and are uncorrelated. Besides, the Ljung-Box statistics are not statistically significant.

CONCLUSION

It is observed from our table 2 summaries that analysis of the same data by different software or different versions of the same software could yield different and at times contradictory results.

This raises some theoretical and computational issues. To reduce controversies over model selection it is often advised that model selection should not be based on a single criterion but on many criteria. For instance Eviews 5.1 uses AIC and Schwarz criterion (Schwarz, 1978) while Eviews 7 adds an extra Hannan-Quinn criterion (Hannan and Quinn, 1979) for such purpose. Apart from these information criteria, statistics such as R^2, log likelihood, Durbin-Watson statistic, standard error of regression, etc. should be examined too. The R software used here uses AIC and residual variance estimate only.

Programming error cannot be ruled out too. Further research needs be done to unravel the reason why differences of computational results exist between software and proffer a solution for this undesirable situation.

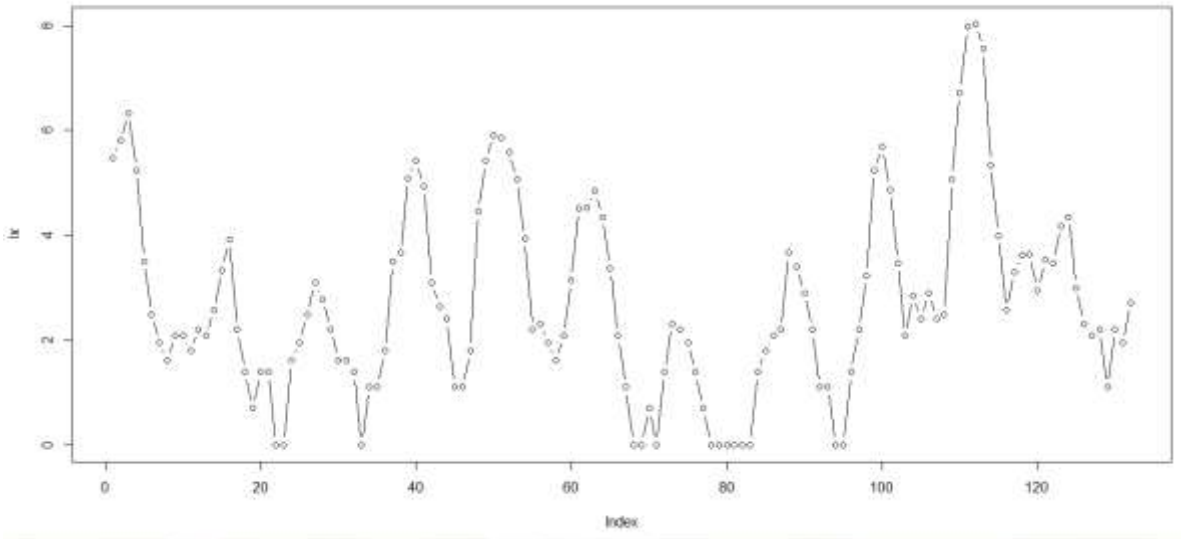

Figure 1: Time Plot of the Differences of the Seasonal Differences of the Log-Transformed Data

Table 1: Relevant Model Statistics

Sarima Model	AIC	Residual variance estimate
$(2,1,2)\times(1,1,1)_{12}$	340.64	0.6998
$(2,1,1)\times(1,1,1)_{12}$ *	322.10 *	0.6158 *
$(1,1,2)\times(1,1,1)_{12}$	340.47	0.7100
$(1,1,1)\times(1,1,1)_{12}$	327.38	0.6166
$(2,1,3)\times(1,1,1)_{12}$	Not applicable	Not applicable
$(1,1,3)\times(1,1,1)_{12}$	340.27	0.6963

*Optimum

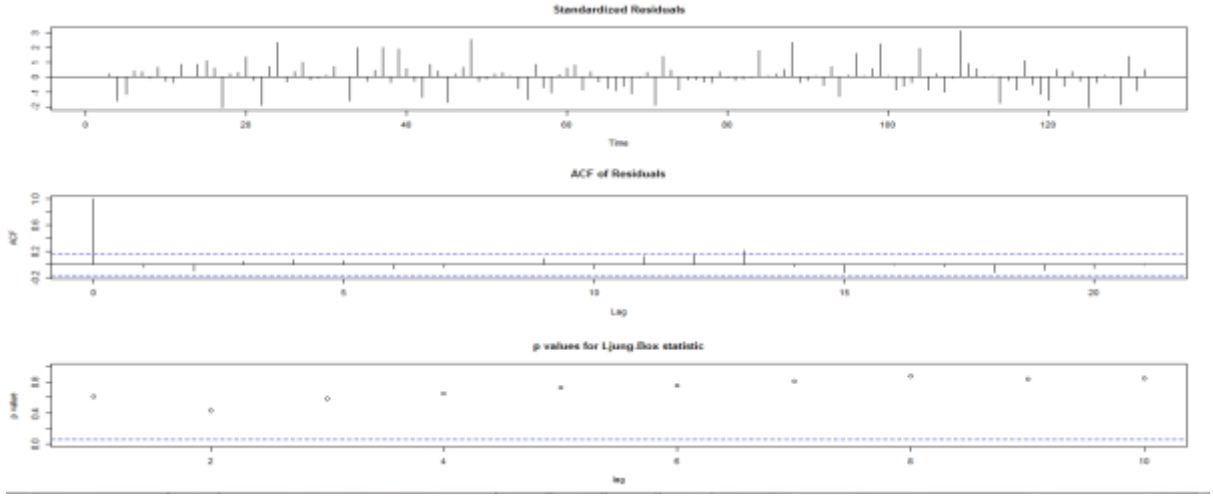

Figure 2: Analysis of the Residuals of Model (2)

Table 2: Comparison of the Model Selection Summaries

Sarima model	Martinez *et al.*	Etuk and Ojekudo	Current work
$(2,1,2)\times(1,1,1)_{12}$	1st	2nd	4th
$(2,1,1)\times(1,1,1)_{12}$	3rd	1st	1st
$(1,1,2)\times(1,1,1)_{12}$	4th	4th	5th
$(1,1,1)\times(1,1,1)_{12}$	6th	3rd	2nd
$(2,1,3)\times(1,1,1)_{12}$	2nd	5th	Non-invertible
$(1,1,3)\times(1,1,1)_{12}$	5th	6th	3rd

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Knowledge and Perception of Undergraduate Nursing Students in Tertiary Institution in Northern Nigeria towards the Introduction of Internship for Graduates of Nursing in Nigeria

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Abstract
Internship refers to a period during which a fresh graduate in certain profession is receiving practical training in a work environment. The study determines the knowledge and perception of BNSc students in Ahmadu Bello University, Zaria. This was a cross sectional descriptive study in which 184 students were selected through stratified random sampling technique and used for the study. Method of data collection was by the use of structured administered questionnaire. Analysis was by the use of Statistical Package for Social Sciences version 21. Correlation coefficient was used to show the relationship between variables. The findings of the study revealed that, majority of the respondents (78%) were females, age range 18-45 years (median=31years). Most (65%) were of Islamic religion. Some (48.4%) of the students entered the department through University Matriculation Examination (UME). All the students were aware of internship. Majority (92.2%) were of the view that, internship will help plan and provide quality nursing care to patients and also help gain work experience. Majority (95.7%) were of the opinion that internship should be for a period of 1 year. Most (91.5%) demonstrated the need for more practical skill to enable them be recruited for jobs. More than half (63.3%) of the nurses strongly agreed that there is need to include the internship programme into the BNSc curriculum. The result on the relationship between the need for more practical skills and the introduction of internship showed a correlation coefficient of r=+1.00 signifying a positive correlation. Determining the relationship between the need for recruitment of graduate nurses and the introduction of internship, the result showed a correlation coefficient of r=+1.00 also signifying a positive correlation.

Keywords: *Knowledge, Perception, Students, Internship, Graduates.*

INTRODUCTION

The period of post qualification work experience and training is called internship. The term internship therefore refers to a period during which a fresh graduates from certain profession receive practical training in a work environment. Nursing Internship program is an "earn while you learn" program designed to facilitate the role transition from novice/novice beginner to competent[1]. An internship is a work-related learning experience for individuals who wish to develop hands on work experience in a certain occupational field. Most internships are temporary assignments that last approximately three months up to a year[2]. Internship for Nurses in Nigeria becomes necessary following the introduction of the generic baccalaureate university education for preparing professional Nurses. The programme started in Obafemi Awolowo University, (OAU) in 1973[3].

The ppurpose of internship is to expose fresh generic graduates who have been criticized deficient in practical skills to acquire more practical skills for practice as well as to qualify them for full registration and licensure from professional statutory body. This provide the new nurse graduate with opportunities for professional growth and autonomy leading to active participation as members of clinical team. At the Cleveland clinic Health system in United State, the graduate nurse internship program is a transition from a student to a professional Nurse4. Entry requirement is evidence of official graduation from an accredited school of Nursing (Faculty or department) among other things peculiar to their setting. Duration of the program is 1—12 weeks consisting of 40hrs work weeks. New graduates who complete a nursing internship program have more professional self-confidence and job satisfaction and are less stressed because they are in a supportive environment[5, 6]. It has been estimated that it takes new graduates at least one year to master a job with successful organization socialization [7]. They also do not feel skilled, comfortable or confident for as long as one year after hire[5]. Internship is practiced in some African countries. In Nairobi, Kenyatta, Baraton, Moi and Great Lakes universities, 214 graduate nurses protested the delay in the issuance

of their internship letters by the Ministry of Medical Services. They stormed the Ministry of Health headquarters at Afya House demanding the release of their internship letters[8].

The concept of internship is new to nursing education in Nigeria. Scholars in Nursing had highlighted the need for the introduction of Internship for graduants of nursing profession in Nigeria [9]. The Nursing and Midwifery Council of Nigeria has a structure for the programme yet to be implemented[10]. The products or graduates of generic Nursing program have been criticized world wide of being deficient in practical skills which is the core of patient care. Many countries have adopted internship into their Nursing training program as a remedy or solution to tackle any deficiency in practical skills and clinical competence among the products of the generic program. Nigeria is yet to adopt internship into her generic Nursing educational program.
The objectives of this study were;

To determine the knowledge of the students about internship in Nursing; to determine the undergraduate nursing students perception towards the introduction of internship for nurses,

To determine the relationship between the need for more practical skills and the introduction of internship and to determine the relationship between recruitment and retention of graduate nurses and the introduction of internship.

MATERIALS AND METHOD

The study area was Department of Nursing Sciences, ABU-Zaria Kaduna State, Nigeria. The Department is located on the 3rd floor of the three story building of the faculty of medicine. It started in 1997 with a total number of five students under the leadership of late Dr. (Mrs.) Z.Y. Yusuf as the Head of Department (HOD). The Department has graduated nine sets numbering about seven hundred students and has grown tremendously both in the number of students and staff strength. It

runs a five years undergraduate programme and had commenced her post graduate programme in 2013/2014 academic session.

RESEARCH DESIGN

A descriptive cross sectional survey design was adopted for this study. This is because it deals with accurate and factual description and summary of the actual situation under study[11].

POPULATION OF STUDY

This consists of Bachelor of Nursing Sciences students of the department of Nursing Sciences, A.B.U. The total number of students was 460

SAMPLE SIZE DETERMINATION

This was by using the formular by Nwana (2007) [12], which stated that, for a population of hundreds, 40% of the population could serve as a sample size for the population. Thus, sample size of 184 students were used for the study.

SAMPLING TECHNIQUE

Stratified random sampling technique was used in which the classes were grouped into stratum. Students were selected by simple random sampling method from the different strata based on the number of students in each class.

INSTRUMENT FOR DATA COLLECTION

This was by the use of structured questionnaire which consisted of both closed and open ended questions. The questionnaire was made up of four sections and the questions captured the objectives of the study. All questionnaires administered were retrieved and used for the study within five days.

METHOD OF DATA ANALYSIS

This was by the use of Statistical Package for Social Sciences, Version 21. Results were presented in frequency distribution tables and percentages and correlation coefficient used to show the relationship between variables.

RESULTS

All completed questionnaires (184) were used for the analysis. The sociodemographic characteristics of the respondents are shown in Table 1.

Table 1: Socio-Demographic Characteristics

1a. Age in Years	Frequency	Percentage
18-24	88	47.8
25-31	82	44.6
32-38	9	4.9
39-45	5	2.7
Total	184	100

1b. Ethnicity

Ethnic Group	Frequency	Percentage
Hausa	83	45.1
Yoruba	26	14.2
Igbo	5	2.7
Fulani	17	9.2
Others	53	28.8
Total	184	100

1c. Religion

Religion	Frequency	Percentage
Islam	121	65.8
Christianity	63	34.2
Total	184	100

Most of the respondents were females (78.3%), age range 18-45 years (median31years). Almost half of the respondents (47.8%) were aged between 18-24 years (Table 1a). This is not surprising as nursing is usually considered a female profession.

Table 1c revealed that, more than half (65%) of the students were Muslim by religion. This is due to the fact that the study is carried out in a University which is located in a Muslim dominated area.

Table 2: Mode of Entry

Mode of Entry	Frequency	Percentage
UME	89	48.4
Direct Entry	57	31
Remedial	38	20.6
Total	184	100

Table 3: Level of Study

Level		
200	46	25
300	46	25
400	46	25
500	46	25
Total	184	100

Table 2 showed that, majority (48.4%) of the student sentered the department through University Matriculation Examination (UME) and Table 3 shows their level of entry.

Table 4: Knowledge about Internship

Know what Internship is	Frequency	Percentage
Yes	148	100
No	-	-
Total	184	100

Table 5: Whether Internship is Important

Improves Nurses Image	Frequency	Percentage
Yes	184	100
No	-	-
Total	184	100

All the students were aware of internship (Table 4) and believe it will improve the nurse's image (Table 5).The high awareness may be due to the fact that among all the target professional groups, all except nurses undergo the internship programme in their professions.

Table 6: Reasons for Internship

6a. Plan and Implement Quality Nursing Care	Frequency	Percentage
Yes	171	92.9
No	13	7.1
Total	184	100
6b.Gain work Experience/skill	Frequency	Percentage
Yes	184	100
No	-	-
Total	184	100

Majority (92.9%)of the respondents were of the view that, internship will help plan and provide quality nursing care to patients (Table 6a). All respondents as shown in Table 6b were of the opinion that, internship will help gain work experience. The result showed the need for more practical skills for the generic nurses. This is not surprising as the Diploma nurses and the general public have often criticized the students undergoing generic

programme in nursing for not having adequate clinical exposure or experience, because according to them, more time is devoted to theoretical instruction at the expense of clinical exposure.

Table 7: Duration of Internship

Duration	Frequency	Percentage
<1Year	8	4.3
1 Year	176	95.7
>1 Year	-	-
Total	184	100

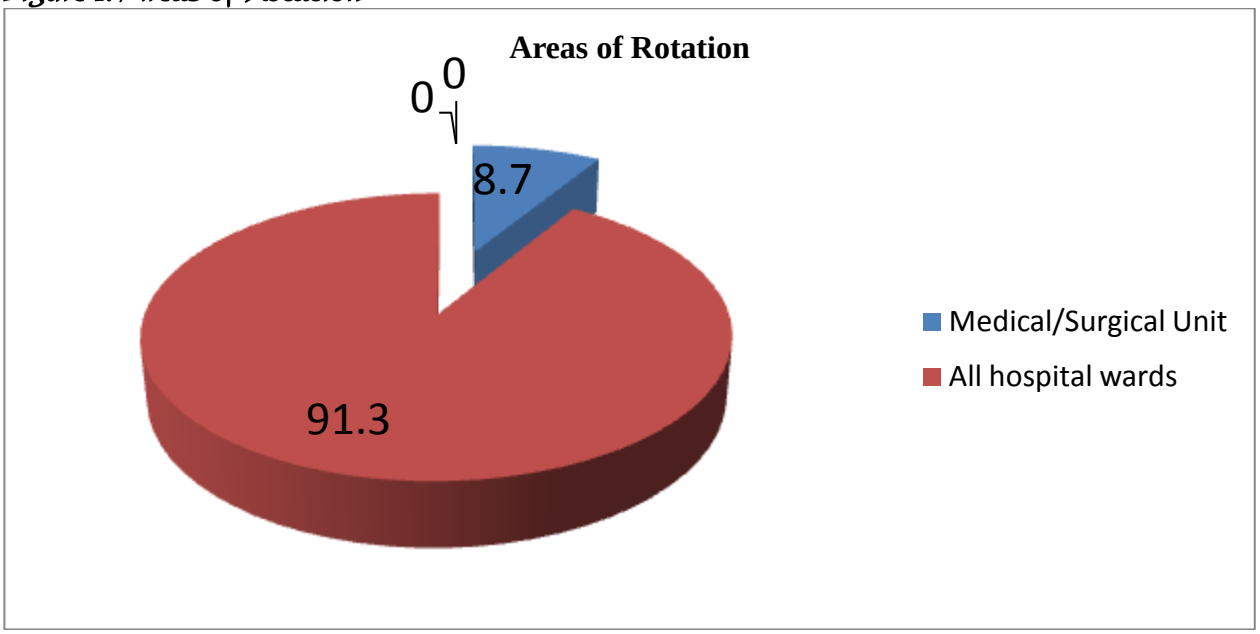
Table 7 indicated that, majority (95.7%) of the respondents are of the opinion that internship should be for a period of 1 year. The recommended 1year is in cognizance with the reviewed structure of 12 months for the nursing programme in Nigerian Universities and duration of internship programme in medicine, pharmacist, medical laboratory scientist and radiologists in Nigeria[14]. This is similar with what occur at King Abdulaziz University[15] and a at Kenya[16] where after passing the Nursing Council Examination, the students undergo 12 months internship program before fully registered to practice.

Table 8: Need for more Practical Skills

Recruitment	Frequency	Percentage
Yes	169	91.5
No	15	8.2
Total	184	100

Almost all the respondents (91.5%) demonstrated the need for more practical skill to enable them be recruited for jobs (Table 8).The result of this study is in line with a study conducted among health care workers at Ahmadu Bello University Teaching Hospital, Zaria where 72.9% of respondents said it is necessary to adopt internship for graduants of nursing education as this will improve the practical and technical skills of the nurse interns.

Figure 1: Areas of Rotation



Most (91.3%) were of the view that all the students should be rotated to all the wards in the hospital (Figure 1).

Figure 2: Perception towards Internship

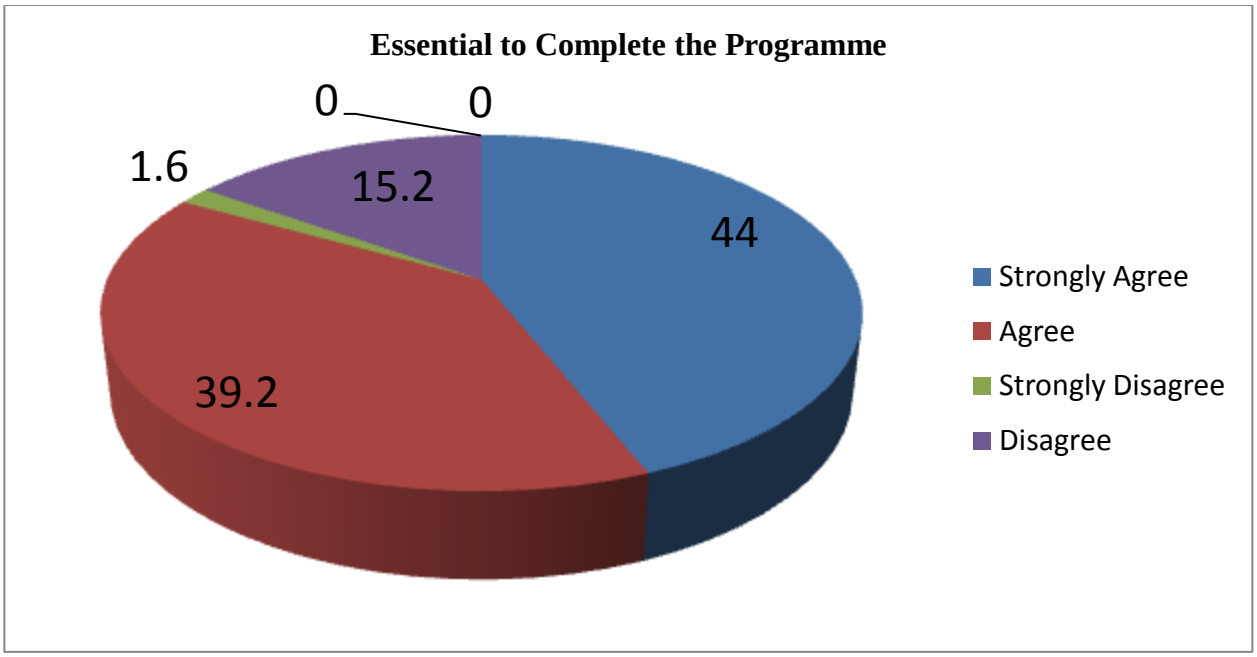


Figure 2 further showed that, 44% of the respondents strongly agreed that, it is essential to complete the internship programme.

Figure 3: Include Internship into BNSc Programme

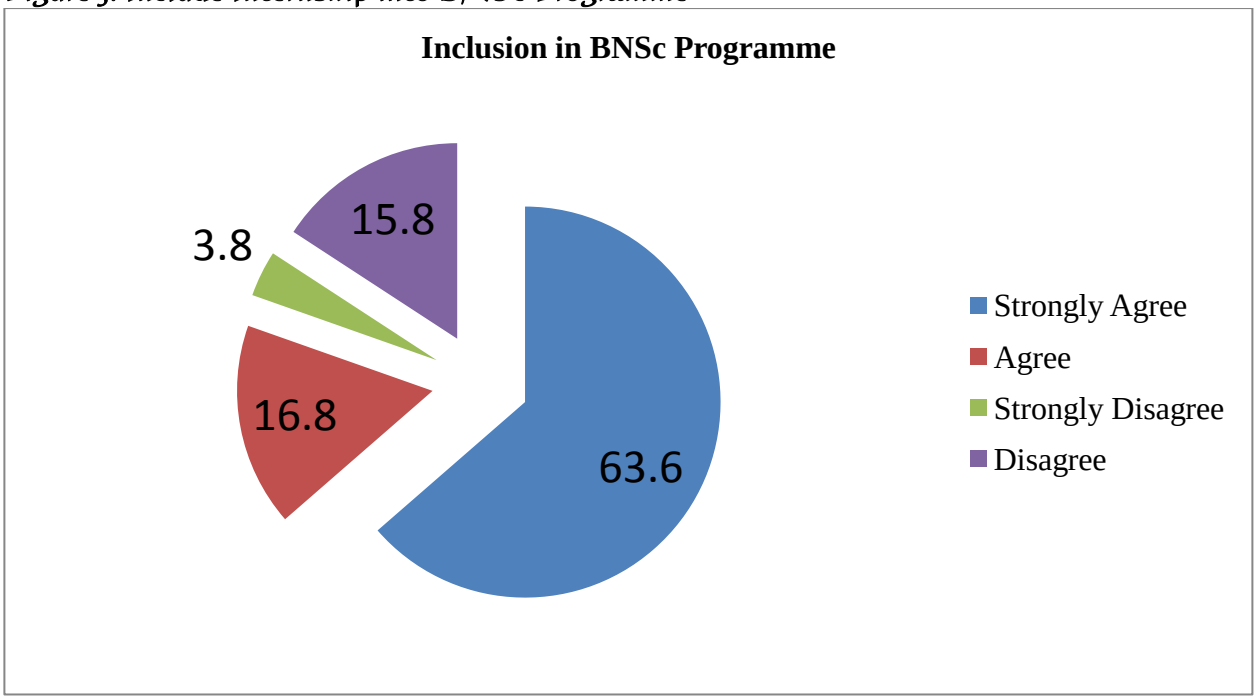


Figure 3 showed that, 63.3% of the nurses strongly agreed that there is need to include the internship programme into the BNSc curriculum. Most respondents (97.1%) also suggested training enough preceptors and clinical instructors for supervision and clinical training of interns. This finding is also in line with the observation made by Yusuf[9] that generic graduate nurses "may have theory but lack adequate practical exposure and competence" paramount to nursing practice. It is not surprising that all the students recommend internship and majority are of the view that it will improve both their image and practical skill. No doubt, internship has been described as a kind of work experiences program employed for graduate professionals such as Law, Medicine, and Pharmacy among others. Its purpose is to expose fresh graduates of those professions that are practically intensive to the practice or clinical area to acquire and consolidate more practical skills and technical knowledge necessary to practice their profession as well as to qualify them for full registration and licensure from professional statutory body. Internship for nurses in Nigeria becomes necessary following the introduction of the generic baccalaureate university education for preparing professional nurses[13].

The result on the relationship between the need for more practical skills and the introduction of internship showed a correlation coefficient of r=+1.00 signifying a positive correlation. On determining the relationship between the need for recruitment of graduate nurses and the introduction of internship, the result showed a correlation coefficient of r=+1.00 signifying also signifying a positive correlation.

CONCLUSION

The study revealed great awareness about internship programme among the students. The findings also showed that implementation of internship into BNSC programme is necessary because it will improve the skills of the generic nurses and also improve their image. It further revealed the preparedness and acceptance of internship among the students. The findings from this study will serve as a consideration to adopt internship into the generic Nursing Education in Nigeria as other health care

practitioners. It will also serve as a useful guide that will help to forestall obvious or anticipated problems in Nursing in Nigeria and further provide the basis for making appropriate recommendations for the proposed internship program. There is therefore the need for Nursing and Midwifery Council of Nigeria to set up a committee to work out a thoughtful plan of action for the implementation of internship into generic nursing education in Nigeria.

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India's Food Crisis *viz.* Risk Inducing Factors-Entitlement Failure: Empirical Evidence of Crop Production in Rajasthan State, India

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Abstract
The study empirically investigated the sources of production instability in Rajasthan State, India. Time series data spanning from 1994-2015 (post-green revolution) *viz.* area, yield and production of 17 crops produced in 27 potential districts and the state were used and meticulously analyzed using Coefficient of Variation and Hazell technique. Results indicated high variability/fluctuation in yield to be the major cause of production instability in all the kharif crops and some rabi crops like wheat and mustard. On the contrary, high instability in area was the major source of production instability for crops like taramira, gram, barley, cumin and coriander. Performance of kharif crops were poor in general, as the production and productivity of crops were observed to be declining. Therefore, location specific technology development is needed in order to give higher yield even in adverse weather condition, along with price support, which would eventually expand the production. Rabi crops performed better; as well their production increase was contributed by increased area and yields. However, this performance was subjected to high instability in both area and yields. Technological inputs like seeds, fertilizers, pesticides and location-specific production technologies, timely and assured electricity supply were important factors that will minimize instability, thus, further increase in production. Furthermore, creation of other infrastructural facilities like irrigation is imperative to increase acreage and production stability.
Keywords: Instability; Area; Yield; Production; Kharif & Rabi crops; Rajathan; India.

INTRODUCTION

The fundamental postulate of the modern welfare state is to help the people in fulfillment of their needs for a decent and comfortable livelihood. In this context, it is widely recognized that in the hierarchy of human needs, food ranks first since the survival of Homo-sapiens hinges on it. As such, it is a matter of paramount importance for the state to accord overriding priority to the concerns for food security, more so, in a world where aid and trade in food have to be tools of international diplomacy. There is a growing concern in different quarters on the issues, "will there be enough food for our children"? This question does cause alarm, particularly in developing countries, because developed countries have successfully tackled this problem through sustained growth over time.

In India, the expanding population which is at present estimated to be 110 crores is likely to cross 145 crores by the year 2030. This will necessitate on an average above 4 percent growth in food production in order to achieve self-sufficiency. To be fed, the population needs at least 270 million tonnes of food grains and more in the near future; which will necessitate an overall increase in food production. The country has put food security high on the national agenda; from being a substantial net food importer in the 1970s, it became self-sufficient in grain production from the early 1980s and more than self-sufficient in the 1990s till date. The darker side of Indian development during the last half century has been that the economic growth did not percolate to the rural poor as "trickle down" has failed to work. The critical appraisals of Indian planning strategy have clearly shown that land reforms neither could be carried out to the extent of eliminating unequal land holdings nor the economic growth could bring prosperity to the rural small and marginal farmers to the extent as would have been expected. Therefore, the future crisis in the food front emanates not entirely in meeting the expected rise in the demand in the production front but more importantly in the distribution front-equitable distribution of not only resources but also equitable distribution of gains from economic growth. However, the country often proclaimed self-sufficiency in food production, yet things do not seem to be very bright particularly in near

future. If another green revolution is not experienced by India in near future, it is expected to import annually 40 million tonnes of foodgrains by the year 2030.

Agricultural production in Rajasthan State has undergone substantial changes; production in the state has increased due to adoption of high yielding varieties, use of chemical fertilizer and development of irrigation structures. Studies *viz.* Sadiq and Grema (2016); Vanpal *et al.* (2015); Swain (2013); Swain *et al.*(2012); Dutta and Kapadia (2011); Kumawat and Meena (2005), all found out that growth in Rajasthan State agricultural production was associated with instability, which adversely affected production, employment and income distribution, thus, hampering economic growth. To promote economic development, it becomes imperative to identify risk inducing factors in crop production in the state and potential district levels. Therefore, the essence of this research is to describe empirically sources of production instability of various selected crops of Rajasthan State in the last two decades. These sources of instability were quantified by decomposing variance of production into various sources *viz.* area variance, yield variance, area-yield covariance and higher order interaction between area and yield.

RESEARCH METHODOLOGY

Rajasthan State is characterized by varied agro-climatic conditions which favours cultivation of large number of crops. The present study made use of time series data on area, production and productivity, covering post-green revolution period, spanning from 1994-2015, obtained from secondary sources viz. Statistical Abstract of Rajasthan State; Directorate of Economics and Statistics (manual), Rajasthan State; Vital Agriculture Statistics, Directorate of Agriculture, Jaipur, Rajasthan State. Criterion for crop selection was that, a crop must have a minimum of 2.5 lakh hectare of area under cultivation during the last 4-5 years (2010/11-2015), and since aggregate analysis may not depict a true picture, only potential districts

which account for 50 percent share in the total area under cultivation of a particular crop were selected. Thus, selected crops with respective potential producing districts are presented in Table 1. The spanning period was divided into two phases; Period I (1994-2004) and Period II (2005-2015), in order to have decade wise comparisons. Coefficient of Variation (CV); Instability Index model and Hazell technique, were used to analyze the data.

Table 1: Selected crops with respective potential producing districts

Crops	Districts
Bajra (*Pennisetum typhoides*)	Barmer, Jodhpur, Churu and Nagaur
Barley (*Hordeum vulgare*)	Jaipur, Sikar, Ajmer and Bhilwara
Coriander (*Coriandrum sativum*)	Kota
Cotton (*Gossypium hirsutum*)	Sri Ganganagar
Cumin (*Cuminum eynum*)	Barmer and Jalore
Gram (*Cicer arietinum*)	Sri Ganganagar, Churu, Jaipur and Jhunjhunu
Groundnut (*Arachis hypogea*)	Jaipur, Chittorgarh, Sawai Modhopur and Bikaner
Guar (*Cyamopsis tetragonoloba*)	Churu, Barmer, Sri Ganganagar and Nagaur
Jowar (*Sorghum bicolor*)	Ajmer, Pali Tonk and Nagaur
Maize (*Zea mays*)	Udaipur, Bhilwara and Chittorgarh
Moong (*Vigna radiata*)	Nagaur, Jodhpur, Jalore and Ajmer
Moth (*Phaseolus aconitifolius*)	Bikaner, Churu and Barmer
Rapseed and Mustard (*Brassica juncea*)	Sri Ganganagar, Bharatpur, Alwar, Sawai Madhopur and Tonk
Sesamum (*Sesamum indicum*)	Pali, Jodhpur and Nagaur
Soyabeans (*Glycine max*)	Kota and Jhalawar
Taramira (*Eruca sativa*)	Nagaur, Bikaner and Pali
Wheat (*Triticum aestivum*)	Sri Ganganagar, Jaipur, Bharatpur, Alwar, Kota and Bundi

EMPIRICAL MODEL

Measurement of Instability

The measurement of instability requires that an implicit or explicit judgment be made as to what constitutes the acceptable variability and unacceptable variability. In time series analysis, the trend is removed from the data before instability is measured on the ground that, those trends are predictable and do not constitute instability. Deviation from the trend constitutes the variability in question, hence used for measurement of instability. Therefore area and productivity for each crop with respect to each selected districts and the state as a whole were de-trended for each time period separately using linear functional form.

$Y_t = a + bt + e_t$ ………………………………………………….. (1)

Where,

Y_t = dependent variable (area or productivity);

t = time trend

e_t = random residual

After de-trending the data, the residuals (e_t) were centered on the mean area or productivity for each period, Y, resulting in de-trended time series data of the following form:

$\bar{Y} = e_t \mp Y$ ………………………………………………………….. (2)

De-trended production data for each crop with respect to each district and the state as a whole were obtained by multiplying the de-trended area with de-trended productivity.

Instability was measured for all the time period by estimating the coefficient of variation of production, area and productivity. Following Sadiq (2015), CV is specified below:

$$CV = \frac{\sigma_{ij}}{\overline{X}_{ij}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

CV = coefficient of variation;

σ_{ij} = standard deviating of the i^{th} variable in the j^{th} crop; and,

X_{ij} = mean of the i^{th} variable in the j^{th} crop.

Sadiq and Grema (2016) stated that, one important point should be noted in connection with the use of C.V., which is the most commonly used index for measuring instability. CV has an easy interpretation in the context of measuring an overall variation in the data not showing any trend. But usually, when we have time series for variables showing some kind of trend, which may be linear or non-linear, CV does not take into account any such time trends of the data while measuring instability in the variate values. Therefore, it may be desirable for general applicability that an index of instability should be so derived as to give information about the trend exhibited in the data on the variable under study. Sadiq and Grema (2016) applied the following index as a measure of instability in time series data:

$I = CV^2 (1-R^2)$ …….. (4)

I= Instability;

CV = coefficient of variation; and,

R^2 = coefficient of determination.

Sources of Instability

To examine instability sources, production instability was decomposed into its sources, *viz.,* area variance, yield variance, area-yield covariance and higher order interaction between area and yield by using the following Hazell technique:

$V(Q) = \bar{A}^2 V(Y) + \bar{Y}^2 V(A) + 2AY(A,Y) - COV(A,Y)^2 + R$ ……. (5)

*W*here,

$\bar{V}(Q)$ = Production Instability/Production variance;

$\bar{A}$ = Mean area;

$\bar{Y}$ = Mean yield;

V(Y) = Yield variance;

V (A) = Area variance;

COV (A,Y) =Area-yield covariance;

$COV(A,Y)^2$ = Higher order covariance between area and yield; and,

R = Residual term.

RESULTS AND DISCUSSION

Sources of Production Instability of Kharif Cereal Crops

Jowar Crop

Results in Table 2 revealed production instability of jowar crop in Ajmer and Pali districts to be 83.41 percent and 81.28 percent respectively, during Period I, and remained almost the same in Pali district in Period II; slightly declined in Ajmer district during Period II. However, Nagaur district witnessed a decline from 83.20 percent to 54.93 percent in Period II. Tonk district experienced increase in production instability from 47.20 percent in Period I to 57.30 percent in Period II. Also, the state observed increase in production instability of jowar crop. Yield variance was observed to be the

major production instability source of jowar crop in all the selected districts and the state during the period under consideration. The yield variance declined from 105.13 percent; 130.62 percent and 94.02 percent during Period I to 93.59 percent; 92.76 percent and 87.66 percent during Period II in Ajmer, Nagaur districts and Rajasthan State, respectively. The yield variance increased from 73.54 percent and 82.85 percent in Period I to 100.33 percent and 87.93 percent during Period II in Pali and Tonk districts respectively. In Nagaur district, the area-yield covariance was observed to be the nullifying factor of production instability. The high yield variance needs to be tackled to reduce the production instability of jowar crop in Rajasthan State.

Maize Crop

Production instability of maize was low when compared to other kharif cereals of Rajasthan State (Table 2). Results showed a decline from 42.74 percent; 42.57 percent; 30.01 percent and 36.04 percent during Period I to 25.30 percent; 25.62 percent; 17.97 percent and 14.43 percent in Period II in Udaipur, Bhilwara, Chittore districts and Rajasthan State, respectively. Findings revealed that maize production variance was mainly due to yield variance; estimated yield variance were 92.04 percent; 93.27 percent; 113.01 percent and 86.17 percent in Udaipur, Bhilwara, Chittore districts and Rajasthan State, respectively during Period II. However, area variance was found to be less than 3 percent in all the districts as well as the state in both periods. Therefore, it can be inferred that maize is the stable food crop of the studied area of Rajasthan State.

Bajra Crop

Production instability of bajra increase in Churu and Barmer districts, from 68.61 percent and 82.36 percent in Period I to 77.71 percent and 88.09 percent, respectively, during Period II. However, it declined in Jodhpur and Nagaur districts and Rajasthan State, from 85.14 percent; 66.22 percent and 47.59 percent in Period I to 80.58 percent; 30.93 percent and 36.40 percent in Period II, respectively. Decomposition analysis of production variance indicates yield variance to be the major contributor of production

instability in all the districts and Rajasthan State during both periods. However, the yield variance declined over time from 103.36 percent; 96.05 percent; 83.86 percent and 82.99 percent during Period I to 77.32 percent; 83.12 percent; 63.14 percent and 70.38 percent during Period II in Jodhpur, Barmer, Nagaur districts and Rajasthan State, respectively. In Churu district, yield variance increased from 75.47 percent in Period I to 82.55 percent during Period II. In Nagaur district, area-yield covariance was found to be the next important source of production instability in both periods (Table 2).

Table 2: Sources of production instability of kharif crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Jower crop					
Period I					
Ajmer	83.41	0.77	105.13	-1.48	-4.41
Nagaur	83.2	17.02	130.62	-64.29	16.65
Pali	81.28	4.74	73.54	-3.09	24.81
Tonk	47.2	2.94	82.85	8.37	5.84
Rajasthan	**31.09**	**5.47**	**94.02**	**-5.48**	**5.99**
Period II					
Ajmer	81.1	0.72	93.59	5.66	0.03
Nagaur	54.93	17.05	92.76	-10.81	1.01
Pali	81.89	0.87	100.33	-0.43	-0.77
Tonk	57.3	3.11	87.93	3.24	5.71
Rajasthan	**37.82**	**5.53**	**87.66**	**2.83**	**3.97**
Maize crop					
Period I					
Udaipur	42.74	1.62	93.86	13.26	-8.75
Bhilwara	42.57	3.13	102.39	10.36	-15.89
Chittore	30.01	0.8	93.64	6.92	-1.37
Rajasthan	**36.04**	**2.57**	**100.37**	**6.8**	**-9.73**
Period II					
Udaipur	25.3	0.19	92.04	5.81	1.97
Bhilwara	25.62	1.01	93.27	5.82	-0.1
Chittore	17.97	2.39	113.01	-11.08	-4.33
Rajasthan	**14.43**	**1.99**	**86.17**	**9.79**	**2.05**

Bajra crop					
Period I					
Churu	68.61	3.38	75.47	15.28	5.87
Jodhpur	85.14	1.7	103.36	2.08	-7.13
Barmer	82.36	3.88	96.05	2.73	-2.66
Nagaur	66.22	3.28	83.86	12.24	0.63
Rajasthan	**47.59**	**5.71**	**82.99**	**17.32**	**-6.03**
Period II					
Churu	77.71	0.68	82.55	9.68	7.1
Jodhpur	80.58	1.23	77.32	15.8	5.64
Barmer	88.09	1.04	83.12	13.11	2.72
Nagaur	30.93	6.71	63.14	28.35	1.8
Rajasthan	**36.4**	**3.31**	**70.38**	**23.26**	**3.05**

Sources of Production Instability of Rabi Cereal Crops

Wheat crop

Instability in the production of wheat declined over time in Jaipur, Alwar, Bharatpur and Sri-Ganganagar districts (Table 3). Major sources of production instability in these districts were area variance and yield variance. Furthermore, it was observed that area-yield covariance contributed in reducing the production instability in these districts. In Kota, Bundi districts and Rajasthan State, the instability in wheat production was found to increase due to increase in area-yield covariance.

Barley crop

Production instability of barley crop in Jaipur district was observed to be lowest and it further declined to 12.81 percent in Period II from 16.53 percent in Period I. Ajmer district exhibited maximum production instability and increased to 34.60 percent in Period II from 29.03 percent in Period I. However, Sikar district witnessed a decline in production instability, while Bhilwara district and the state observed increased production instability. In Ajmer district, yield variance emerged as the major source of production variance. Furthermore, in Jaipur, Sikar, Bhilwara districts and Rajasthan State, area variance was found to be the major determinant of production variance. Decomposition analysis of production variance indicated area

variance and yield variance to be the major sources of production instability (Table 3).

Table 3: Sources of production instability of rabi cereal crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Wheat crop					
Period I					
Jaipur	15.39	18.13	90.62	-11.28	2.53
Alwar	14.81	37.17	85.75	-28.09	5.18
Bharatpur	15.19	54.91	101.3	-48.93	-7.27
S/Ganganagar	24.31	42.81	71.31	0.88	-15
Kota	17.03	30.93	44.69	23.46	0.93
Bundi	16.51	21.74	95.46	-22.03	4.82
Rajasthan	**13.4**	**43.59**	**46.66**	**12.00**	**-2.25**
Period II					
Jaipur	12.55	26.83	70.79	4.17	-1.78
Alwar	9.09	23.54	132.85	-53.75	-2.65
Bharatpur	6.96	22.06	128.58	-23.73	-18.91
S/Ganganagar	17.18	19.97	69.37	18.94	-8.28
Kota	17.45	32.31	110.82	-41.13	-2
Bundi	22.69	17.52	60.48	17.85	4.15
Rajasthan	**14.75**	**34.66**	**50.24**	**18.83**	**-3.74**
Barley crop					
Period I					
Ajmer	29.03	31.25	33.74	23.31	11.7
Jaipur	16.53	56.57	27.25	11.54	4.65
Sikar	29.84	77.83	28.45	-1.3	-4.97
Bhilwara	27.23	27.26	33.63	30.98	8.14
Rajasthan	**16.54**	**64.76**	**18.03**	**13.75**	**3.45**
Period II					
Ajmer	34.6	47.00	52.99	1.5	-1.49
Jaipur	12.81	80.74	41.58	-17.27	-5.04
Sikar	24.19	53.22	31.75	2.72	12.31
Bhilwara	33.15	53.01	17.38	41.09	-11.48
Rajasthan	**17.19**	**64.15**	**31.47**	**11.61**	**-7.23**

Sources of Production Instability of Kharif Pulse Crops

Moth crops

Production instability of moth crop declined over the period in all the districts as well as the state (Table 4). In Bikaner district, yield variance declined from 85.73 in Period I to 71.52 percent in Period II, and the area-yield covariance increased from 13.36 in Period I to 25.27 percent during Period II. Estimated yield variance of moth were 96.93 percent and 42.59 percent in Churu and Barmer districts, respectively in Period I, which increased to 99.86 and 69.64 percent, respectively during Period II. Findings observed yield variance to be the major determinant of production instability in all the districts and the state as a whole. However, area variance was observed to be low in all the districts as well as the state which indicates possible sustainability of moth crop in the studied area. Therefore, production of moth can be expanded by adoption of agricultural technology such as development of drought tolerant variety, thus, minimizing yield fluctuations.

Moong crop

Moong crop production was observed to be very high in Jalore district (124.35 percent), followed by Jodhpur district (106.81 percent) and Nagaur district (74.61 percent) in Period I. However, it slightly declined in Period II *viz.* 99.10, 93.11 and 67.02 percent, respectively. Production instability remained almost the same i.e 75 and 64 percent in Ajmer district and Rajasthan State in both periods. It was observed that the production variance of moong in Ajmer district was explained by yield variance (86.09 percent) and area variance (11.63 percent) during Period I, while yield variance (78.51 percent) and higher order area-yield covariance (13.72 percent) were the major factors during Period II. Jodhpur district experienced increase in yield variance over time; in Jalore district, yield variance remained constant (81 percent) in both periods; in Nagaur district, major source of moong production variance was yield variance (61.91 percent) and area-yield covariance (39.01 percent) during Period I. In Period II, major sources of production instability were yield variance (68.85 percent) and area variance (24.47 percent). In Rajasthan State, yield

variance (87.84 percent) was the major source of production variance in Period I, which declined to 60.13 percent in Period II. However, Dominant source of production instability in the studied area was yield variance (Table 4).

Guar crop

Production instability of guar crop declined in Churu, Sri-Ganganagar, Barmer districts and Rajasthan State. Estimates of production instability were 71.98 percent, 63.40 percent, 94.97 percent and 63.71 percent, respectively during Period I, and declined to 49.33 percent, 42.50 percent, 88.26 percent and 48.16 percent, respectively in Period II. However, production instability of gaur in Nagaur district was found constant (62 percent) in both periods. Results of decomposition analysis revealed very high share of yield variance in production variance, with it increasing overtime for all districts except for Sri-Ganganagar district. Estimated gaur yield variance in Churu, Sri-Ganganagar, Barmer, Nagaur districts and Rajasthan State were 86.32 percent, 171.53 percent and 111.67 percent, respectively during Period II. It can be inferred that area-yield covariance and higher order area-yield covariance emerged as nullifying factors of production variance in Sri-Ganganagar and Nagaur districts (Table 4).

Table 4: Sources of production instability of kharif pulse crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Moth crop					
Period I					
Bikaner	73.51	4.6	85.73	13.36	-3.69
Churu	77.01	0.56	96.93	2.73	-0.22
Barmer	112.07	27.53	42.59	18.42	11.46
Rajasthan	**67.93**	**3.99**	**91.79**	**19.32**	**-15.1**
Period II					
Bikaner	64.11	5.1	71.52	25.27	-1.89
Churu	44.61	5.03	99.86	0.74	-5.63

Barmer	94.17	8.16	69.64	12.35	9.85
Rajasthan	**53.92**	**3.75**	**78.35**	**19.67**	**-1.77**
Moong crop					
Period I					
Ajmer	74.2	11.63	86.09	5.96	-3.68
Jodhpur	106.81	7.77	72.11	13.44	6.68
Jalore	124.35	4.63	80.91	1.2	13.26
Nagaur	74.61	22.36	61.91	39.01	-23.28
Rajasthan	**64.57**	**6.41**	**87.84**	**13.84**	**-8.09**
Period II					
Ajmer	74.2	11.63	86.09	5.96	-3.68
Jodhpur	106.81	7.77	72.11	13.44	6.68
Jalore	124.35	4.63	80.91	1.2	13.26
Nagaur	74.61	22.36	61.91	39.01	-23.28
Rajasthan	**64.57**	**6.41**	**60.13**	**13.84**	**-8.09**
Gaur crop					
Period I					
Churu	71.98	1.14	86.32	11.13	1.41
S/Ganganagar	63.4	37.13	171.53	-45.57	-63.09
Barmer	94.97	10.19	67.29	30.22	-7.7
Nagaur	61.36	1.19	92.48	11.8	-5.47
Rajasthan	**63.71**	**8.06**	**74.17**	**32.81**	**-15.03**
Period II					
Churu	49.33	6.22	134.64	26.17	-14.71
S/Ganganagar	42.5	53.51	55.82	-10.47	1.14
Barmer	88.26	3.96	79.75	9.99	6.3
Nagaur	62.87	19.15	195.75	-68.29	-46.61
Rajasthan	**48.16**	**12.69**	**111.67**	**-18.45**	**-5.91**

Sources of Production Instability of Rabi Pulse Crop

Gram crop

Estimated production instability of gram were 33.45 percent; 27.20 percent; 60.87 percent and 28.41 percent in Jaipur, Sri-Ganganagar, Churu districts and Rajasthan State, respectively during Period I, and increased to 50.57 percent; 61.36 percent; 120.57 percent and 49.66 percent, respectively during Period II. In Jhunjhunu district, production instability declined from 97.74 percent during Period I to 76.99 percent during Period II. Decomposition analysis of production variance of gram crop showed that area variance was the major determinant of production variance in Jaipur, Jhunjhunu districts and Rajasthan State during Period II. Area-yield covariance was found to be the major source of production variance in Sri-Ganganagar and Churu districts. However, in Churu district, four factors *viz.* area variance, yield variance, area-yield covariance and higher order area-yield covariance contributed almost equally in Period II (Table 5).

Table 5: Sources of production instability of rabi pulse crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Gram crop					
Period I					
Jaipur	33.45	32.03	33.00	37.92	-2.95
S/Ganganagar	27.20	77.79	48.74	-28.70	2.17
Jhunjhunu	97.74	46.75	37.37	-17.54	33.41
Churu	60.87	19.35	56.77	37.78	-13.90
Rajasthan	**28.41**	**55.29**	**19.09**	**20.99**	**4.61**
Period II					
Jaipur	50.57	75.52	11.11	17.34	-3.97
S/Ganganagar	61.36	25.20	29.90	34.23	10.66
Jhunjhunu	76.99	91.25	23.55	1.38	-16.17
Churu	120.57	19.99	27.50	26.83	25.67
Rajasthan	**49.66**	**64.98**	**8.72**	**23.14**	**3.16**

Sources of Production Instability of Kharif Oilseed Crops

Groundnut Crop

Estimated production instability of groundnut was 51.96 percent, 50.22 percent and 23.63 percent in Sawai-Madhopur, Bikaner and Chittore, respectively during Period I, and declined to 41.30 percent; 25.02 percent and 18.70 percent, respectively during Period II. The major contributing factor in production variance was yield variance, followed by area variance and area-yield covariance. The yield variance in Rajasthan State was 115.62 percent in Period I, and declined to 60.11 percent during Period II. For Bikaner district, the production variance was due to area variance (67.63 percent), followed by yield variance (55.05 percent). It was also observed that area-yield covariance and higher order covariance of area and yield were the nullifying factors of production variance in Bikaner district (Table 6).

Soyabean Crop

The Jhalawar district showed decline in production instability of soyabean from 65.55 percent in Period I to 30.38 percent in Period II. Kota district and Rajasthan State had increase in production instability, from 19.94 percent and 20.08 percent in Period I to 39.72 percent and 27.60 percent in Period II. Area variance emerged as major factor in production variance, followed by yield variance during both periods in Kota district. However, both area variance and yield variance declined from 189.31 percent and 52.55 percent in Period I to 41.45 percent and 37.24 percent, respectively during Period II. Jhalawar district experienced production instability due to high yield variance in both periods. The share of yield variance in production instability increased over time in Jhalawar district (Table 6).

Sesamum Crop

Estimated production instability of sesamum in Jodhpur, Nagaur, Pali districts and Rajasthan State were 108 percent; 80.78 percent; 72.46 percent and 66.97 percent, respectively during Period I. It declined to 94.98 percent; 51.66 percent; 70.21 percent and 38.76 percent, respectively, during Period II. The major sources of production instability were found to be yield variance,

followed by area-yield covariance in both periods. However, yield variance of sesamum crop declined from 78.86 percent; 66.61 percent and 82.97 percent during Period I to 74.82 percent; 53.69 percent and 63.92 percent during Period II in Jodhpur, Nagaur and Pali districts, respectively. At state level, yield variance exhibited increase magnitude, from 68.02 percent during Period I to 88.33 percent in Period II; yield variance constituted large share in production instability (Table 6). Therefore, yield risk minimizing policy may be devised in order to boost production of sesamum crop in the state.

Table 6: Sources of production instability of kharif oilseed crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Groundnut crop					
Period I					
Jaipur	37.92	25.39	52.76	21.95	-0.11
S/Madhopur	51.96	15.76	52.75	16.91	14.58
Bikaner	50.22	20.32	51.19	14.79	13.7
Chittore	23.63	26.48	81.11	-5.95	-1.64
Rajasthan	**20.1**	**31.88**	**115.92**	**-34.84**	**-12.96**
Period II					
Jaipur	42.08	19.7	49.48	17.53	13.29
S/Madhopur	41.3	31.75	62.71	20.25	-14.71
Bikaner	25.02	67.63	55.05	-10.78	-11.89
Chittore	18.7	31.57	78.97	-10.23	-0.31
Rajasthan	**27.03**	**8.53**	**60.11**	**26.98**	**4.38**
Soyabean crop					
Period I					
Kota	19.94	189.31	52.55	-114.57	-27.29
Jhalawar	65.55	32.54	75.76	31.52	-39.83
Rajasthan	**20.08**	**113.38**	**66.1**	**-49.91**	**-29.57**
Period II					

Kota	39.72	41.45	37.24	6.44	14.87
Jhalawar	30.38	6.63	95.12	-1.14	-0.6
Rajasthan	**27.6**	**24.32**	**54.37**	**12.38**	**8.93**
Sesamum crop					
Period I					
Jodhpur	108	7.05	78.86	17.42	-3.33
Nagaur	880.78	17.61	66.61	28.79	-13.01
Pali	72.46	7.77	82.97	15.77	-6.51
Rajasthan	**66.97**	**12.49**	**68.02**	**28.12**	**-8.63**
Period II					
Jodhpur	94.98	3.86	74.82	6.6	14.7
Nagaur	51.66	18	53.69	17.37	10.94
Pali	70.21	8.41	63.92	17.56	10.1
Rajasthan	**38.76**	**19.05**	**88.33**	**-6.12**	**-1.26**

Sources of Production Instability of Rabi Oilseed Crops

Rapseed and mustard

Sources of production variance of rapseed and mustard crop in the districts and Rajasthan State are presented in Table 7. Results revealed that Alwar and Sri-Ganganagar districts experienced increase in production instability over time, while Bharatpur, Sawai-Mahopur and Tonk districts showed declined production instability. Production instability of rapeseed and mustard in Rajasthan State was approximately 19 percent for both periods. During Period I, area variance was observed to be the dominant factor in production variance in all the districts, as well as in the state. However, in Period II, production variance was caused by both area variance and yield variance. In Alwar, Bharatpur and Sawai-Madhopur districts, yield variance emerged as major component of production variance, while in Sri-Ganganagar and Tonk districts and in the state, area variance was observed to be the major source of production variance. Area-yield covariance emerged as nullifying factor in Sawai-Madhopur and contributing factor to production variance in Sri-Ganganagar district during Period II.

Taramira crop

The production instability of taramira crop increased from 115.02 percent; 138.81 percent; 106.47 percent and 37.11 percent in Bikaner, Nagaur, Pali districts and Rajasthan State, respectively during Period I, to 191.95 percent; 166.50 percent; 130.57 percent and 105.88 percent, respectively during Period II. Area variance was found to be the major source of production instability in the studied area in both periods, because area under taramira crop depends on seasonal rainfall (Table 7).

Table 7: Sources of production instability of rabi oilseed crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Rapseed and mustard crop					
Period I					
Alwar	14.89	67.58	39.72	-1.53	-5.76
Bharatpur	23.17	36.64	36.58	22.44	4.34
S/Madhopur	35.02	42.74	34.1	25.54	-2.38
S/Ganganagar	21.49	63.63	46.64	-5.51	-4.76
Tonk	47.23	57.72	21.94	9.82	10.52
Rajasthan	**19.01**	**96.37**	**10.54**	**-4.03**	**-2.9**
Period II					
Alwar	18.24	15.93	67.66	13.98	2.44
Bharatpur	19.84	20.76	85.28	-6.97	0.93
S/Madhopur	18.05	72.81	76.95	-48.37	-1.39
S/Ganganagar	28.72	43.31	30.58	28.92	-2.81
Tonk	29.29	49.97	44.36	4.95	0.72
Rajasthan	**19.03**	**75.45**	**33.21**	**-8.42**	**-0.25**
Taramira crop					
Period I					
Bikaner	115.02	399.62	29.74	-113.98	-215.38
Nagaur	138.81	16.26	51.97	9.74	22.03
Pali	106.47	126.31	21.24	-4.68	-42.87

Rajasthan	**37.11**	**113.95**	**78.54**	**-46.34**	**-46.15**
Period II					
Bikaner	191.95	74.6	3.35	4.65	17.4
Nagaur	166.5	149.05	8.8	-27.92	-29.93
Pali	130.57	152.39	13.53	-20.04	-45.87
Rajasthan	**105.88**	**104.76**	**1.47**	**-6.16**	**-0.07**

Sources of Production Instability of Other Crops

Cotton crop

The production instability of cotton declined over the period, from 32.38 percent and 31.58 percent in Sri-Ganganagar district and Rajasthan State in Period I, to 28.94 percent and 20.78 percent, respectively during Period II. Decomposition analysis of production instability indicated yield variance increased from 67.73 percent in Period I to 73.18 percent during Period II in Sri-Ganganagar district. In Rajasthan State, it declined from 68.99 percent to 54.50 percent during period II. It was observed that the next important contributor to the production instability was area variance (Table 8).

Cumin crop

Decline in production instability of cumin crop was observed in Rajasthan State. In Jalore district, area variance was the major source of production instability in both periods. In Barmer district, area variance was the major determinant of production instability in Period I, while during Period II, yield variance was the major determinant factor of production instability. However, in Rajasthan State, area variance was the major source of production instability in both periods, but declined over time (Table 8).

Coriander crop

Production instability of coriander in Kota district and Rajasthan State declined over time from 47.94 percent in Period I, to 21.79 percent and 28.52 percent, respectively in Period II. The production variance of coriander crop due to yield variance was 67.84 percent, followed by area variance (38.03 percent) during Period I in Kota district. However, during Period II,

production variance was due to area variance (127.92 percent), followed by yield variance (31.67 percent). Area-yield covariance was observed to be the nullifying factor of production variance in Kota district during Period II (Table 8).

Table 8: Sources of production instability of other crops

Particulars	Production Instability	Area variance	Yield variance	Area-yield covariance	Higher order covariance
Cotton crop					
Period I					
S/Ganganagar	32.38	20.03	67.83	9.4	2.73
Rajasthan	31.58	16.79	68.99	19.05	-4.84
Period II					
S/Ganganagar	28.94	8.32	73.18	4.75	13.75
Rajasthan	20.78	28.6	54.5	5.27	11.62
Cumin crop					
Period I					
Jalore	52.58	66.14	33.09	-14.15	14.92
Barmer	56.5	45.65	39.39	11.7	3.27
Rajasthan	50.00	81.17	16.36	-8.08	10.55
Period II					
Jalore	39.72	69.11	37.63	8.51	-15.25
Barmer	44.32	9.71	105.6	-1.86	-13.45
Rajasthan	36.177	67.2	13.54	18.45	0,82
Coriander crop					
Period I					
Kota	47.94	38.03	67.84	2.00	-7.87
Rajasthan	40.7	44.92	49.23	12.87	-7.02
Period II					
Kota	21.79	127.92	31.67	-45.31	-14.28
Rajasthan	28.52	69.86	113.67	-125.69	42.16

Maximum Contributing Sources of Production Instability

Table 9 identifies maximum contributing sources of production variance in Rajasthan State. Results revealed that the production instability of all the kharif crops was caused mainly by yield variance in all the selected districts as well as in the state, except in Bikaner district for groundnut crop and Kota district for soyabean crop. Mix of area variance and yield variance contributed to production variability in rabi crops. However, area variance emerged as the major contributor of production variance. The production variance of wheat crop in all the selected districts, except Bharatpur district was explained by yield variance. The yield variance was also responsible for production variance in rapeseed and mustard crop in Alwar, Bharatpur and Sawai-Madhopur districts. Yield variance was the major determinant of production variance in Churu district for gram crop, Ajmer district for barley crop and Barmer district for cumin crop.

Table 8: Maximum contributing sources of production instability

Crop	Area variance	Yield variance	Area-yield covariance
Moth		Bikaner, Churu, Barmer, Rajastahn	
Sesamum		Jodhpur, Nagaur Pali, Rajasthan	
Jowar		Ajmer, Nagaur, Pali, Tonk, Rajasthan	
Moong		Ajmer, Jodhpur, Jalore, Nagaur, Rajasthan	
Maize		Udaipur, Bhilwara, Chittore, Rajasthan	
Guar		Churu,	

		S/Ganganagar, Barmer, Nagaur, Rajasthan	
Bajra		Churu, Jodhpur, Barmer, Nagaur, Rajasthan	
Groundnut	Bikaner	S/Madhopur, Chittore, Rajasthan	
Cotton		S/Ganganagar, Rajasthan	
Soyabean	Kota	Jhalwara, Rajasthan	
Wheat	Bharatpur	Jaipur, Alwar, S/Ganganagar, Kota, Bundi, Rajasthan	
Rapseed & mustard	S/Ganganagar, Tonk, Rajasthan	Alwar, Bharatpur, S/Madhopur	
Taramira	Bikaner, Nagaur, Pali, Rajasthan		
Gram	Jaipur, Jhunjhunu, Rajasthan	Churu	S/Ganganagar
Barley	Jaipur, Sikar, Bhilwara, Rajasthan	Ajmer	
Cumin	Jalore, Rajasthan	Barmer	
Coriander	Kota	Rajasthan	

CONCLUSION AND RECOMMENDATIONS

It is essential to identify the risk inducing factors i.e sources of production instability. These sources were quantified by decomposing production variance into various sources *viz.* area variance, yield variance, area-yield covariance and higher order interaction between area and yield. High fluctuating area and yield level were the main cause of crop production instability in all kharif crops, mainly because of high dependence on rainfall, thus, a cause of concern for policy makers to ensure sustained growth of agriculture and farmers livelihood, given that virtually all of them depend on agriculture for income. Rabi crops like wheat and mustard also showed fluctuating yield levels inspite of overall growth over the years. However, high area instability was the major contributing source of production instability of crops like taramira, gram, barley, cumin and coriander. Therefore, since it was observed that in most of the crops, yield variability was more, farmers are advised to avail benefits of crop insurance scheme launched by government to commensurate their returns. Also, government should endeavour to enact insurance scheme for those crops which are yet to be covered by insurance.

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The Frequency of ABO and Rhesus D Blood Group Antigens amongst Blood Donors

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Abstract

The frequency distribution of ABO and Rh.D blood group antigens amongst blood donors in Port Harcourt metropolis was investigated in this study. A total of 150 blood donors recruited in a hospital in Port Harcourt, Rivers State of Nigeria were collected by venepucture from each of the male blood donors and transferred into bottles containing Ethylenediaminetetra-acetic acid (EDTA). Fresh red cell suspension and 20% suspension of known A,B and Rh.D antigens were prepared. Tile agglutination technique was used in the determination of ABO and Rh.D grouping system. The results showed that for the distribution of percentage frequency of ABO blood groups in the study population, 33 donors were blood group A with percentage frequency of 22.0%, 31 donors were group B with frequency of 20.7%, 12 donors were group AB with frequency of 8.0% and 74 donors were group O with highest frequency of 49.3%. For the distribution of percentage frequency of Rh.D blood group among the blood donors, 138 donors with frequency of 92.0% were Rh.D positive while 12 donors with percent frequency of 8.0% were Rh.D negative. When the frequency distribution of Rh.D positive and Rh.D negative subjects in ABO blood groups was assessed, it was shown that blood group O had the highest number of donors with Rh.D positive, of 71 with frequency of 47.3%, then followed by group A with 31 donors with frequency of 20.7%, group B with 27 donors with frequency of 18.0% and lastly group AB with 9 donors with frequency of 6.0%. The Rh.D negative values were 3(2.0%) for group O, 1(0.7%) for group A, 5 (3.3%) for group B and 9(6.0%) for group AB. The study therefore concludes that blood group O with Rh.D positive antigens are the

most common blood groups among the blood donors in Port Harcourt metropolis.
Keywords: Frequency, Blood, Donors, ABO, Agglutination and Rh.D

INTRODUCTION

In 1900 an English scientist Karl Landsteiner when carrying out some experiments with red cells of some individuals and then sera of others observed some interesting results. He found that there were agglutinations in some categories while in other there were no agglutination of the red cells. Continuing his experiment he discovered it was possible to group his findings. Three groups were possible which he classified as A, B, and O groups. It was known that the red cell in group 'A' posses the antigen designated as 'A'. Those with antigen 'B' as group B and those with no antigen on their red cell was designated O (Cheesbrough 2000).

Continuing his experiment it was revealed that blood that has group A antigen has naturally occurring antibodies to the group B antigen (anti-B) and those with group B antigen has naturally occurring antibodies to group A antigen (anti-A). This soon became apparent as the major cause of incompatibility leading to severe transfusion reaction. (Shaw *et al*,2010, Bener *et al*,2012).

Two years after the death of Landsteiner one of his students opened further investigation and discovered a fourth group of red cells which posses both A and B antigen and is designated as group AB. They naturally do not possess any of the A or B antibodies. Thus this blood grouping technique became known as the Landsteiner's ABO blood group system. For this discovery, he was awarded the Nobel price in Medicine at that time. (Schroedar and Jenson 2000, Waseem *et al*; 2012, Jassim 2012).

The adverse reactions in blood transfusion were not totally eliminated following the discovery of A & B antigens hence prompting the need for further investigations. In 1939 Landsteiner and Wiener discovered the

Rhesus antigen. They injected red cells of the monkey macacus rhesus into rabbits thereby stimulating the production of an antibody. This antibody then agglutinates the Rhesus monkey red cells. These antibodies also agglutinate a large percentage of individual meaning they posses the Rhesus antigen and a small percentage of individuals could not be agglutinated. Those whose red cells are agglutinated are known as Rhesus positive while other groups are known as Rhesus negative. (Lawler and Lawier 1971).

Blood transfusion is a very important therapeutic process in modern medicine (Mollison 1993). However, a lot of care is taken in carrying out this all important process. The first aspect of this work which determines to a large extent the success of the therapy is the correct grouping of the donor and the recipient (Adam *et al;* 1996).

When blood is wrongly grouped it leads to an adverse transfusion reaction in the recipient (Baker and Sylverton 1998). In the ABO system, individuals naturally have antibody to the antigen it does not possess.

Antigen-antibody reaction can occur in vivo if proper care is not taken. Antigen antibody reaction leads to agglutination and possible lysing of the red cells. If this occurs, then the purpose of blood transfusion is defeated. For instance, it is not compatible for a group A recipient to be transfused with group B blood. This is because group A individuals has antibody B (Anti-B) and will cause lysing of the transfused B red cells. To avoid adverse transfusion reaction arising from ABO antigen, group compatible blood is always used. (Antee 2010,Kamil *et al,*2010).

Group O individual can donate to any of the four groups individual as universal donor while group AB individuals can receive blood from any of the four blood group individuals as universal recipient (Jaggi and Yadav 2014).

The Rh.D blood group system is similar. Its difference is that wrong transfusion does not result to all immediate adverse transfusion reaction except in a subsequent transfusion. A Rhesus negative donor can donate to a Rhesus positive individuals without any adverse reaction. However, if Rh.D positive blood is given to Rh.D negative individual he or she becomes sensitized and develops antibodies to the Rh.D antigen in the next transfusion (Gravenhorst 1982, Dawti *et al;* 2011).

The frequency of ABO and Rh.D phenotypes varies in different populations throughout the World (Aird 1953). In the study carried out by Mollison *et al;* (1993), the commonest group in the Australian abonigines are groups O and A. France (2002) gave the percentage distribution of whites in the united states as blood group 0,46%, A ,41%, B, 9% and AB 4%. That of the Negroes New Yorkers were given as blood group 0, 25%, group A, 18% group B and AB 5%. The African country of Kenya had a percentage distribution of blood group o as 47.4%, A, 26.2%, B, 22.0% and AB as 4.4% (Lyko *et al;* 1992). European population is 95% Rh.D positive while 5% were Rh.D negative. For the United States 85% of the population were found to be Rh.D positive while 15% were Rh.D negative (France 2002). Marzban *et al;* (1988) gave 90% Rh.D positive and 10% Rh.D negative in Ahwaz region population. Monica (2000) gave the summary of Rh.D positive distribution as Asians 90-98%, Africans 94-95%, Nepalese 99-100% and the Caucasians as 56%.

This study is therefore aimed at investigating the frequency distribution of ABO and Rh.D blood group antigens amongst blood donors in Port Harcourt Metropolis.

MATERIALS AND METHOD

Recruitment of Patients

A total of two hundred and four (204) students in a coeducational institution in Nembe were used in this study. They were made up of one hundred and twenty four (124) males and eighty (80) females.

Collection of Samples

5.0ml. of blood was collected from each of the recruited patients using venepuncture technique and transferred into a bottle containing ethylenediamine tetra acetic acid (EDTA). This was gently rocked to ensure thorough mixing of the blood sample with the anticoagulant.

Preparation of Fresh Red Cell Suspension

This was done using each of the samples to be grouped. Two ml of the samples were transferred from the EDTA bottle to a test tube. 3.0ml of normal saline solution was added to the tube and the contents were mixed and centrifuged for 5 minutes. The supernatant was decanted and this was repeated three times.

20% suspension of known red cells containing the A, B, and Rhesus D antigen were prepared in the same way and used for the serum (reverse) grouping.

Procedures for ABO Grouping

Tile agglutination technique was used in this determination. Microtitre wells were numbered 1-6 and one volume each of anti-A, Anti-B and Anti AB were added to wells 1, 2 and 3 respectively, while one volume each of A Cells, B cells and control 1 (patient cells and serum) were added to wells no. 4,5 and 6 respectively.

To wells numbers 1-3 one volume of patients cells were added whereas in wells number 4 and 5 one volume of patients serum were added. One volume of low ionic strength solution (LISS) freshly prepared was added to each well.

The contents were mixed with separate applicator sticks. The tiles were rocked for four minutes making sure that the contents were not dried. Agglutination was observed, recorded and interpreted.
The contents of wells 4 and 5 served as a check to the actual test carried out on wells 1 to 3, and this process is known as reverse grouping.

Rhesus D grouping

Anti-D reagent and patient washed cells and serum were used. The procedure was the same as for the ABO grouping system except that only two wells were used. One well for the test while the other was used for the control. The result was interpreted as agglutination for Rh.D positive and no agglutination as Rh.D negative as in the ABO system.

RESULTS

The frequency of ABO and Rhesus D blood group antigens amongst blood donors in Port Harcourt has been investigated.

The results showed that for blood group A there were 33 donors with percentage frequency of 22.0%, group B were 31 donors with percentage frequency of 20.7%, group AB were 12 donors with percentage frequency of 8.0% and group O with the highest number of donors of 74 with percentage frequency of 49.3% (figure 1).

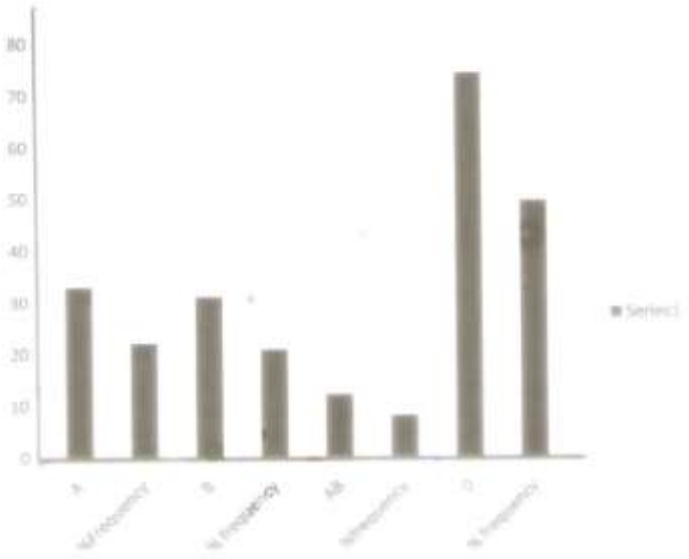

FIGURE 1: FIGURE SHOWING THE DISTRIBUTION OF PATIENTS AND PERCENTAGE FREQUENCY OF ABO BLOOD GROUPS IN THE STUDY POPULATION.

For the distribution of percentage frequency of Rh.D blood group in the studied population, 138 donors with percentage frequency of 92.0% were of Rh.D positive while 12 donors with the frequency of 8.0% were of Rh.D negative (figure 2).

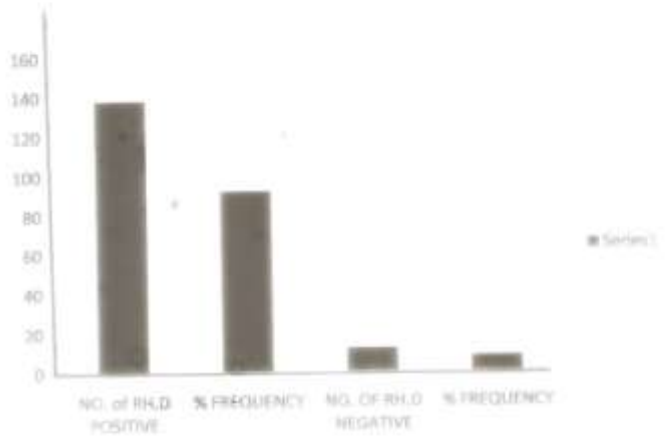

FIGURE 2: FIGURE SHOWING THE DISTRIBUTION OF PERCENTAGE FREQUENCY OF Rh.D BLOOD GROUP IN THE STUDY POPULATION

For the frequency distribution of Rh.D positive and Rh.D negative subjects in the studied population, blood group A had 31 Rh.D positive donors with frequency distribution of 20.7% and 1 Rh.D negative donor with frequency of 0.7%. Blood group B had 27 Rh.D positive donors with frequency of 18.0%. Blood group AB had 9 Rh.D positive donors with frequency of 6.0% and 3 Rh.D negative donors with frequency of 2.0%. Blood group "O" had the highest number of Rh.D positive donors of 71 with the percentage frequency of 47.3% and 3 Rh.D negative with frequency of 2.0%.(Table 1).

Table 1: Table showing the frequency distribution of Rh.D positive and Rh.D negative subjects in ABO blood groups

Blood groups	Rh.D Positive	%frequency	Rh.D Negative	% Frequency
A	31	20.7	1	0.7
B	27	18.0	5	3.3
AB	9	6.0	3	2.0
0	71	47.3	3	2.0
Total	138	92	12	8.0

DISCUSSION

This study investigated the frequency distribution of ABO and Rh.D antigens amongst blood donors in Port Harcourt. The ABO and Rhesus D blood group systems are the most commonly used blood group system in blood transfusion medicine (Frances *et al;* 2002).

The results showed the distribution of percentage frequency of ABO blood group in the study population as blood group A 33 donors with percentage frequency of 22.0%, group B, 31(20.7%), group AB, 12(8.0%) and group o with 74 donors and percentage frequency of 49.3%.

This finding agrees with the results of other investigators who showed that blood group O is most common amongst the population of their

studies just as in this study. (France 2000,Mollison *et al;*1993 and Lykes *et al;*1992).

For the frequency distribution of Rhesus D antigens the study showed that 138 donors with percentage frequency of 92% were Rh.D positive while 12 donors with percentage frequency of 8.0% were Rh.D negative. These results also agrees with that of other investigators which showed that Rh.D positive individuals were higher than the Rh.D negative ones in the population studied. (France 2002, Marzban *et al;*1988 and Monica 2000).

For the frequency distribution of Rh.D positive and Rh.D negative subjects in ABO blood groups. Blood group O was found to have the highest frequency of 71 Rh.D positive individuals with percentage frequency of 47.3%, followed by group A with 31 Rh.D positive with frequency of 20.7%, then group B with 27 Rh.D positive with frequency of 18.0% and group AB with 9 Rh.D positive donors with frequency of 6.0%. The frequency of Rh.D negative donors were 3(2.0%) for group 0, 1(0.7%) for group A, then 5(3.3%) for group B and 3(2.0%) for group AB. These findings also agreed with the findings of other studies cited above since blood group O is shown to have the highest frequency of Rh.D positive donors.

This study therefore concludes that blood group O with Rh.D positive antigens are the most common amongst the blood donors in Port Harcourt metropholis.

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