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Forecasting Wheat Production in Libya Using ARIMA Model-ARIMA

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Abstract:

The wheat crop is a strategic crop in Libya as a food crop and a raw material for some food industries. The study aimed to predict the amount of wheat production in context of Libya during the next six years from 2023-2028. The Auto-regressive Integrated Moving Average (ARIMA) model has been used and relied on Food and Agriculture Organization data from the period 19961 to 2022. The study findings indicated that the ARIMA (AR (1), MA (9), MA (12) model was the most appropriate model for forecasting among selected ARIMA models because it had significant coefficients, lowest volatility, highest AdjR^2, and lowest AIC. Furthermore, it passed all diagnostic tests, where the residuals are white noise and follow normal distribution. Also, there is no heteroscedasticity in the model and had good predictive ability. Finally, the study concluded that wheat production will witness an upward trend during the forecast period (2023-2028).upward trend during the forecast period (2023-2028).

Keywords: Wheat Production, Forecast, ARIMA model, Libya.

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التنبؤ بإنتاج القمح في ليبيا باستخدام نموذج-ARIMA

[1]د.فوزي صالح فرج

1. أستاذ مشارك بقسم الاقتصاد الزراعي، كلية الزراعة، جامعة بنغازي، بنغازي، ليبيا

الملخص

يعتبر محصـــول القمح من المحصـــول الاســـتراتيجي في ليبيا كمحصـــول غذائي وكمادة أولية لبعض الصـــناعات الغذائية. هدفت الدراسة إلى التنبؤ بكمية إنتاج القمح في ليبيا خلال السنوات الست القادمة من 2023-2028. تم اســـتخدام نموذج الانحدار الذاتي المتحرك المتكامل (ARIMA) والاعتماد على بيانات منظمة الأغذية والزراعة من الفترة 19961 إلى 2022. أشارت نتائج الدراسة إلى أن متوسط المتحرك المتكامل(1) (AR (ARIMA) ، (9) MA، MA ((12)كان النموذج الأكثر ملاءمة للتنبؤ بين نماذج ARIMA المختارة لأنه يحتوي على معاملات معنوية وأقل تقلبات وأعلى AdjR2 وأقل AIC علاوة على ذلك، فقد اجتاز جميع الاختبارات التشـخيصـية، حيث كانت البقايا عبارة عن ضوضاء بيضاء وتتبع التوزيع الطبيعي أيضًا. لا يوجد أي تباين في النموذج ولديه قدرة تنبؤية جيدة. وأخيراً توصلت الدراسة إلى أن إنتاج القمح سيشهد اتجاهاً تصاعدياً خلال فترة التنبؤ (2023-2028).واتجاهاً تصاعدياً خلال فترة التنبؤ.(2023-2028) .

الكلمات المفتاحية: إنتاج القمح، التنبؤ، نموذج أريما، ليبيا.

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1. INTRODUCTION.

Agriculture.is.the.cornerstone.of.less.developed.countries.economies.(FAO,.2001).in.order.to.meet.the.people.basic.needs.and.the.production.required.by.other.sectors.(Loizou.et.al..2019)..It.also.exports.workers.to.the.industrial.and.service.sectors.as.a.result.of.increased.growth.in.demand.for.employment.(Eswaran,.2006)..Moreover,.it.is.underpinning.their.food.security,.export.earnings.to.earn.foreign.exchange.for.overhead.investment.for.industries.and.expansion.rural.development.(FAO,.2002)..Furthermore,.it.provides.the.raw.materials.for.the.agro.based.industries.(Praburaj.et.al,.2018).

Agriculture.in.Libya.was.the.main.activity.before.discovered.of.oil.and.absorbed.the.majority.of.the.population.to.work.in.this.sector.as.their.only.source.of.livelihood.(Abdelwhab,.2012)..As.for.its.importance.after.the.discovery.of.oil,.its.contribution.to.the.Libyan.GDP.is.generally.very.minor,.as.its.percentage.in.2019.was.3.69%.(Libyan.Central.Bank,.2022)..These.minor.contributions.increase.and.decrease.according.to.climatic.conditions,.the.economic.situation.of.farmers,.and.government.procedures.towards.the.agricultural.sector..

Among.the.world's,.wheat.is.one.of.the.three.most.important.staple.food.crops.in.the.world.and.being.used.for.human.food.and.livestock.(Shewry,.2009)..It.is.grown.on.more.than.215.million.hectares.and.producing.over.735.million.tons.of.grain.(CrespoHerrera.et.al,.2021)...In.Libya,.wheat.is.considered.one.of.the.most.important.grain.crops..The.average.relative.importance.of.wheat.production.capacity.reached.more.than.60%.of.the.total.grain.during.the.period.(1980.2014)..In.addition,.the.amount.of.wheat.consumed.reached.515.thousand.tons.in.1980.to.about.1158.thousand.tons.in.2014(Al.Warfalli.et.al,.2016)..

2.THE.STUDY.PROBLEM

The.Libyan.state.has.focused.on.the.agricultural.sector.after.the.discovery.of.oil,.with.the.aim.of.diversifying.sources.of.production.and.national.income..It.believed.that.spending.on.agricultural.development.by.establishing.major.agricultural.projectors,.developing.their.infrastructure,.providing.loans.to.farmer,.and.providing.p

roduction.requirement;.it.would.ensure.achieving.self.sufficiency.and.food.security.in.wheat.crop..Despite.these.efforts,.this.goal.of.achieving.self-sufficiency.has.not.been.achieved.and.it.is.still.relying.on.imports,.which.its.quantity.in.2022.was.245465.91.tons..For.this.reason,.this.study.came.to.predict.the.value.of.wheat.production.for.the.coming.years.to.enable.decision.maker.to.put.appropriate.agricultural.policy.to.reduce.the.import.of.this.strategic.commodity.to.produce.it.locally.and.cover.the.deficit.

3.OBJECTIVES.OF.THE.STUDY

In.light.of.these.issues.in.forecasting.wheat.production,.this.study.seeks.to.achieve.the.following.objectives:

1.To.study.the.wheat.production.historical.trend.during.the.period.1961-2022.

2.Selecting.the.best.fit.ARIMA.mod.from.the.ARIMA.models.in.predicting.the.quantity.of.wheat.production.in.Libya..

3.Testing.and.applying.the.best.fit.ARIMA.model.selected.to.predict.the.amount.of.wheat.production.quantity.for.the.coming.years.2023-2028.

4.SIGNIFICANCE.OF.STUDY

The.importance.of.the.research.lies.in.the.fact.that.wheat.production.is.an.important.strategic.material.and.the.most.important.element.in.food.security,.as.it.contains.high.amounts.of.protein,.nitrogen.free.compounds.and.fats,.and.is.a.raw.material.for.many.industries..Therefore,.studying.the.reality.of.this.crop.is.very.important.for.planners,.considering.predicting.future.crop.values.by.using.the.(ARIMA).methodology.as.part.of.planning.in.light.of.agricultural.conditions.and.environment.enables.decision.makers.in.the.agricultural.sector.to.improve.their.plans,.make.them.more.realistic,.and.ensure.efficient.production.progress..The.study.also.seeks.to.enrich.experimental.studies.and.raises.many.points.for.researchers.to.research.and.study.

5.LITERATURE.REVIEW

The.wheat.production.forecasting.issue.has.been.the.subject.of.numerous.studies,.especially.in.developing.countries..Shrivastri.et.al..(2022).used.annual.time.series.data.from.1956.to.2020.in.five.states:.Uttar.Pradesh.(UP).Punjab.(PB).Madhya.Prades

h.(MP).Haryana.Rajasthan.(RJ).to.forecasts.for.wheat.production.in.India.from.2021.to.2030..The.findings.of.the.study.demonstrated.the.best.fit.ARIMA.model.were.determined.as.ARIMA.(1,1,0).for.UP,.ARIMA.(0,1,1).for.PB,.ETS.(M,.M,.N).for.MP,.ETS.(M,.MD,.N).for.Haryana,.ETS.(M,.N,.N).for.JR,.and.ETS.(A,.A,.N)..In.same.year,.the.study.of.Krishna.et.al.(2022).aimed.to.select.ARIMA.model.and.forecast.the.production.and.consumption.of.wheat.in.India..It.used.annual.time.series.data.from.1959.2019

The.results.of.the.study.revealed.that.the.ARIMA.(0,.1,.1).with.drift.was.the.optimal.model.for.production.of.wheat.and.expected.the.production.will.be.1,.13,909.70.thousand.MT.during.the.next.eight.years.

In.another.study.in.India.by.Prabakaran.et.al.(2013).attempted.to.forecast.area.and.wheat.production.in.India.during.the.period.of.1950-51.to.2011.12..Box.Jenkins.Auto.Regressive.Integrated.Moving.Average.(ARIMA).model.was.used.for.the.study.purpose..The.study.stated.in.its.results.that.the.forecast.wheat.production.quantity.in.2015.will.be.79.73,.with.a.maximum.of.about.107.55.thousand.tons.and.a.minimum.of.about.87.92.thousand.tons..In.the.context.of.another.study.in.India,.Patowary.et.al.(2017).aimed.to.build.a.simple.linear.regression.model.with.ARIMA.errors.in.India.for.the.period.of.1960.2016

The.finding.of.the.study.demonstrated.that.the.forecasted.wheat.productivity.revealed.an.increasing.pattern.during.upcoming.10.years.and.its.predictive.quantity.was.estimated.at.108380.66.MT.in.the.year.2027.

Sher.and.Ahmad.(2008).studied.the.future.prospects.of.wheat.production.in.Pakistan..The.study.employs.ARIMA.approach.and.annual.data.during.the.period.1979.to.2006.taken.from.the.Agricultural.Statistics.of.Pakistan.and.Area.Production.(By.Districts),.Ministry.of.Food,.Agriculture.and.Live.Stock.(MINFAL),.Government.of.Pakistan..The.results.of.the.study.showed.that.Pakistan.will.face.a.slight.wheat.shortage.in.the.future,.as.there.is.growth.of.1.6%.based.on.the.future.expectations.of.the.study..In.another.study,.Abdulla.and.Hossain.(2015),.they.targeted.to.use.the.Auto.Regressive.Integrated.Moving.Average.

(ARIMA).model.to.forecast.the.production.of.wheat.in.Kushtia.district,.in.addition.to.Bangladesh.as.a.whole.

The.study.showed.that.the.optimal.model.was.ARIMA.(1,.2,.and.1).in.Kushtia.district,.while.in.whole.Bangladesh.was.ARIMA.(0,.2,.and.1)...Moreover,.the.study.also.indicated.that.the.optimal.models.behaved.better.statistically.after.comparing.the.original.series.with.the.forecasting.series,.and.it.is.concluded.that.it.can.be.relied.on.two.optimal.models.in.the.process.of.predicting.wheat.production.

In.Arab.countries,.Atia.and.Atwa.(2009).sought.to.find.an.appropriate.ARIMA.model.for.forecasting.for.area,.average.yield.and.the.production.of.wheat.crop.in.Egypt.and.Beni-Swef.Governorate..The.study.relied.on.time.series.data.from.1982.1983.to.2006.2007..

The.study.showed.from.its.results.that.the.values.for.the.forecasts.for.the.wheat.production.for.Egypt.were.it.has.been.estimated.as.58.6243.million.ardab.in.2007/2008.and.68.3664.million.ardab.in.2012/2013..As.for.Beni.Swef.Governorate,.the.production.was.2.890.million.ardab.in.2007/2008.and.3.364.million.ardab.in.2012/2013..In.the.same.context.in.Iraq,.Madlul.and.Baker.(2020).used.the.annual.time.series.data.over.the.time.1988.to.2018.to.employ.the.ARIMA.model.for.predicting.the.crop.of.whea

The.author.points.out.through.the.results.of.the.proposed.Arima.(1.0.1).model,.Iraq's.wheat.production.will.be.increase.during.the.next.ten.years..Also,.the.growth.rate.of.wheat.production.reaching.0.94%.was.higher.than.the.annual.average.in.the.study.period.1988-2018.

Jalić,.et.al.(2021).relied.on.the.time.series.from.the.Food.and.Agriculture.Organization.database.covering.the.period.from.1998.to.2020.in.Bosnia.and.Herzegovina.to.apply.ARIMA.model.for.forecasting.wheat.production.for.a.period.of.five.years.(2021.2025)

The.results.of.the.study.showed.that.ARIMA.(1,.1,.and.10).was.relied.on.it.to.forecasting.process..It.also.showed.that.there.will.be.a.trend.of.decreasing.wheat.production.during.the.next.five.years.by.3%.each.year..The.study.justified.that.this.decline.can.be.attributed.to.the.climatic.factor

s.that.influenced.the.direction.of.expected.production..In.addition.to,.prices.in.regional.and.global.markets.that.cannot.be.predicted..Also,.to.the.government.procedures.that.took.towards.the.wheat.production..Finally,.the.study.of.Latifi.and.Shabanali.(2022).employed.Arima.and.the.Artificial.Neural.Network.(ANN).models.are.used.to.forecast.wheat.production.in.Iran..Annual.wheat.production.data.covered.the.period.between1961.1962.to.2018.2019..The.results.of.the.study.concluded.that.the.artificial.neural.network.(ANN).model.is.better.than.the.ARIMA.model.(1,.1,.and.1).in.predicting.wheat.production.by.using.its.efficient.parameter.

6.STUDY.METHODOLOGY

In.this.study,.the.secondary.data.was.used.and.collected.over.the.period1961.2022.from.Food.and.Agriculture.Organization.data..The.mixed.method.(Descriptive.and.quantitative.analysis).used.to.achieve.the.research.objectives,.provides.a.better.understanding.of.a.study.problem,.and.gets.results.closer.to.reality..Descriptive.analysis.was.used.to.describe.historical.of.wheat.production.trend.during.the.period.(1961.2022)..As.for.the.quantitative.analysis,.the.ARIMA.model.was.used.to.predict.wheat.production.from.the.period.2023.to.2028..

Specification.of.ARIMA.model.

An.autoregressive.integrated.moving.average.is.a.statistical.analysis.model.that.uses.time.series.data.to.either.understand.predict.future.tren

The.arima.model.is.denoted.by.ARIMA.(p,.d,.q),.where.“p.“stands.for.the.order.of.the.auto.regressive.process,..“d.“.is.the.order.of.differencing.and.“.q“..is.the.order.of.the.moving.average.process..The.ARIMA.(1,.1,.and.1).model.is.formulated.as.follows.:-

yt.=.(1+ϕ).yt-1+.ϕ.yt-2.+.θ0.+.*e*t.–.θ1*e*t-1.(Amin.et.al,.2014).

Where,.ARIMA.(1,.1,.1).indicates.the.model.has:.one.lag.of.the.dependent.variable.“p.“.(1),.the.variable.being.used.is.of.first.difference.stationary.“d“.(1).and.one.lag.of.the.error.term.“.q“..It.involves.a.number.of.procedural.steps,.which.are.as.follows:.plot.the.historical.graph,.check.the.stationary.of.the.data,.plot.of.ACF.and.PACF.to.identify.potential.AR.and.MA.model,.identify.the.best.fit.ARI

MA.model,.plot.ACF.and.PACF.for.residuals.of.ARIMA.model.to.ensure.no.more.information.is.left.for.extraction,.and.forecasting.the.series.using.the.best.fit.ARIMA.model.

7..RESULTS.AND.DISCUSSION.

7.1..Descriptive.analysis.of.wheat.production.series

The.wheat.crop.is.considered.one.of.the.modern.crops.from.a.historical.perspective.in.Libya,.and.it.is.also.considered.a.food.crop.compared.to.the.chronological.age.of.barley..It.has.also.been.relied.upon.as.a.food.material.and.became.the.first.strategic.crop.as.a.result.of.the.increase.of.citizen's.income.and.uses.as.a.raw.material.in.the.food.industries.(Abdel.Razek,.2007)..

Based.on.Table.1.and.Figure.1,.it.illustrates.the.wheat.production.fluctuates.from.year.to.year..This.is.due.to.the.fact.that.wheat.production.depends.on.rain,.as.its.quantity.increased.from.29992.tons.in.1961.to.209737.tons.in.1983,.and.after.that.it.returned.and.decreased.to

Table1..Wheat.production.quantities.in.Libya.during.1961-2002.

Year	Quantity.of.Wheat.production.(tons)	Year	Quantity.of.Wheat.product
1961	29992	1992	125000
1962	33600	1993	126000
1963	34100	1994	120000
1964	28000	1995	117000
1965	56913	1996	124000
1966	57788	1997	156400
1967	62221	1998	140000
1968	52041	1999	130000
1969	78421	2000	125000
1970	27159	2001	125000
1971	17726	2002	125000
1972	41585	2003	125000
1973	67327	2004	125000
1974	38682	2005	125000
1975	75134	2006	104000
1976	133101	2007	104000

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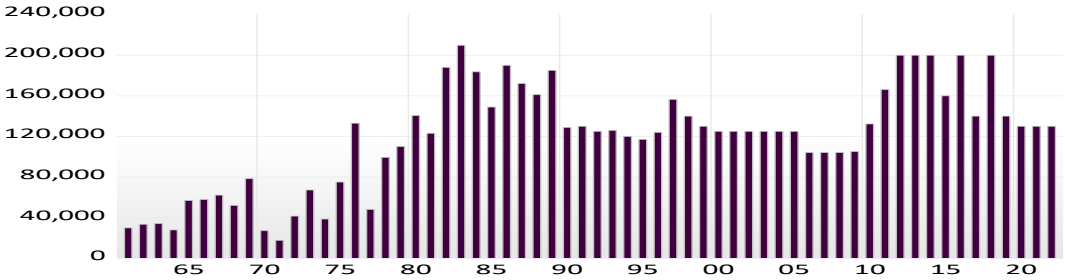
Year	Quantity.of.Wheat.production.(tons)	Year	Quantity.of.Wheat.product
1977	48117	2008	104000
1978	99295	2009	105000
1979	110000	2010	132239
1980	140500	2011	166000
1981	123110	2012	200000
1982	188000	2013	200000
1983	209737	2014	200000
1984	183634	2015	160000
1985	149000	2016	200000
1986	190000	2017	140000
1987	172000	2018	200000
1988	161011	2019	140000
1989	185000	2020	130000
1990	128760	2021	130000
1991	130000	2022	130000

Source:.Faostat.Production.Data..Food.and.Agriculture.Organization,.United.Nation.http://www.fao.org/en/#data/QCL



.Figure1..Wheat.Production.Quantities.(Tons).during.the.period.1961.2022

.130000.tons.in.2022,.with.an.annual.average.production.1191122.5.tons.during.the.last.62.years.from.1961.to.2022..In.this.duration.the.maximum.value.of.wheat.production.was.in.1983;.the.lowest.value.of.wheat.was.in.1971.

On.the.other.hand,.the.standard.deviation.was.51708.14;.it.is.lower.than.the.mean.119122.5..This.means.that,.the.data.are.more.reliable.or.clustered.closely.around.the.mean,.while.the.probability.of.jarque.bera.was.0.38.which.is.greater.than.0.05..This.

means.that.the.null.hypothesis.is.cannot.be.rejected,.and.there.is.no.evidence.to.suggest.that.the.data.doesn't.follow.a.normal.distribution..In.another.word,.the.data.of.wheat.production.under.the.study.investigation.follow.a.normal.distribution.

7.2..Model.identification.

The.first.step.in.identification.of.the.model.is.to.identify.the.initial.characteristics.of.the.wheat.production.time.series.by.showing.the.plot.of.this.series..The.curve.of.wheat.production.shows.a.general.trend..As.the.amount.of.wheat.production,.the.plot.shows.that.there.was.a.stable.trend.from.1961.1964,.a.sharp.increase.in.1965.and.a.drop.around.1971.and.again.a.sharp.increase.in.wheat.production.in.the.year.1983.as.shown.in.figure2.

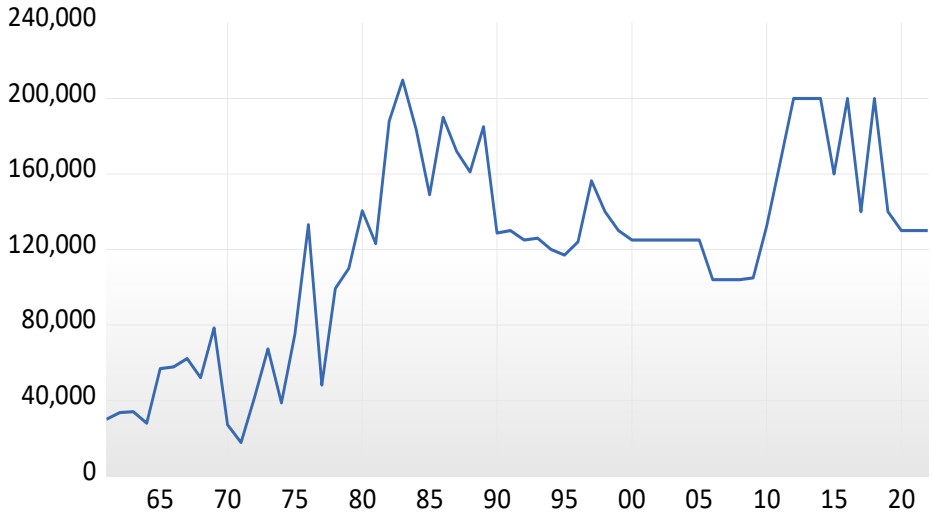


Figure2..Line.graph.of.Wheat.Production

Also,.Augmented.Dickey-Fuller.(ADF).and.Phillips.Perron.(PP).tests.are.employed.to.analyse.the.stationarity.of.wheat.production.series..The.ADF.and.PP.results.in.Tables.2.and.3.showed.that.wheat.production.series.not.stationary.because.the.probability.was.greater.than.5%..It.is.meaning.that.it.is.not.stationary.than.it.should.be.accept.the.null.hypothesis,.which.states.the.existence.of.a.unit.root.

Table2..Results.of.Unit.Root.Test.for.ADF.Test

	At.Level		At.First.Difference		The.Decision
Constant	t-Stat	Prob	t-Stat	Prob	I(1)
	-2.084	0.25	-11.59	0.00	
Constant.And.Trend	-2.03	0.58	-11.60	0.00	I(1)
Non	-0.190	0.61	-11.63	0.00	I(1)

Source:.Prepared.by.the.researcher.based.on.the.outputs.of.Eviews.12.

After.that,.the.tests.were.repeated.at.the.first.difference,.it.was.found.that.the.series.was.stationary.and.the.probability.was.less.than.5%..Therefore,.the.null.hypothesis.was.rejected.and.the.alternative.hypothesis.was.accepted,.which.states.that.there.is.no.unit.root.and.the.series.stationary.at.the.first.difference.as.it.is.clear.in.Table3.

Table3..Results.of.Unit.Root.Test.for.PP.Test

	At.Level		At.First.Difference		The.Decision
Constant	t-Stat	Prob	t-Stat	Prob	I(1)
	-2.44	0.13	-11.80	0.00	
Constant.And.Trend	-2.937	0.15	-11.69	0.00	I(1)
Non	-0.319	0.56	-11.81	0.00	I(1)

Source:.Prepared.by.the.researcher.based.on.the.outputs.of.Eview12.

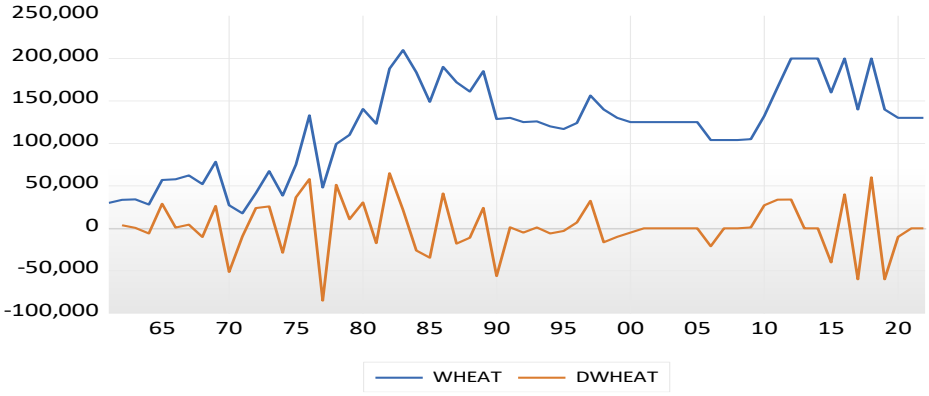


Figure3.Line.graph.of.Wheat.Production.at.level.and.the.first.difference

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In.addition,.the.results.of.correlograms.at.level.showed.same.result.as.shown.in.figure.4,.it.can.see.that.from.the.Box.Liwung.statistic.at.leve,.which.has.a.value.of.Q.=.200.28.at.the.lagged.24,.which.is.a.big.value.and.this.evidence.that.the.wheat.production.series.is.not.stationary.in.the.level.and.stationary.in.the.first.difference..

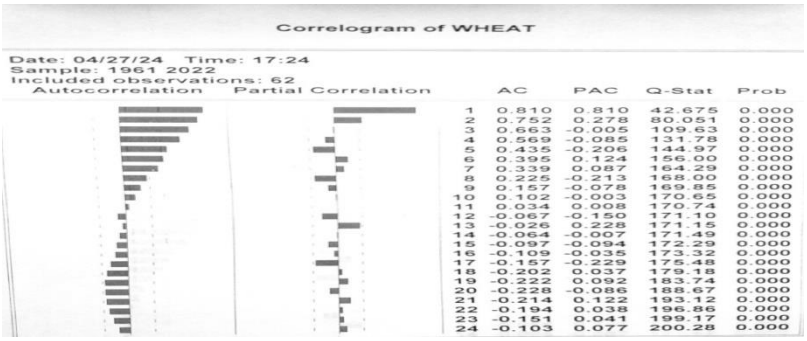

Figure4..The.auto.correlation.(ACF).and.partial.auto.correlation.(PACF).at.level

7.3..Model.Estimation

After.ensuring.the.stationary.of.the.wheat.production.series,.the.estimation.and.selecting.the.appropriate.model.for.AIRMA.model.step.comes,.where.the.main.goal.of.this.stage.is.to.identified.model.ARIMA.(p,.d,.q).The.auto.correlation.function.(ACF).refers.to.the.autoregressive.components.'q'.of.the.model,.while.partial.auto.correlation.function.(PACF).function.gave.an.indication.for.the.parameter.p.and.they.are.considered.among.of.the.model.specification..

In.order.to.determine.the.order.of.the.autoregressive.component.("p").and.the.order.of.the.moving.average.component.("q").at.the.first.difference,.as.shown.in.Figure.5..The.component.of.P.is.(1),.and.MA.components.are.MA.(5).and.MA.(12)..Accordingly,.three.potential.candidate.models.for.ARIMA.models.have.been.identified.namely.(1.1.1),.(1.1.5),.and.(1.1.12)..

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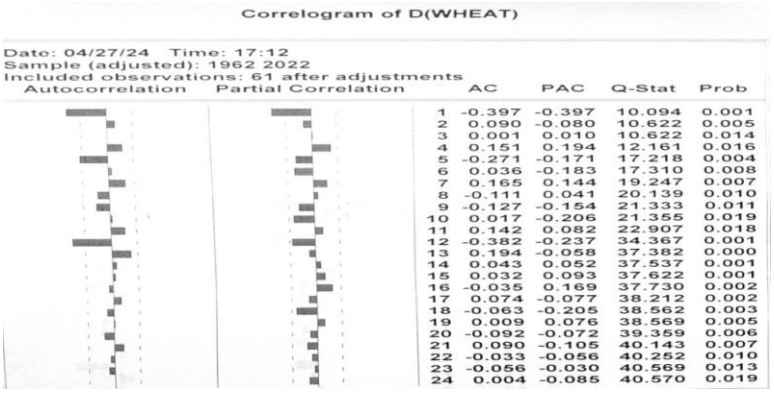

	AC	PAC	Q-Stat	Prob
1	-0.397	-0.397	10.094	0.001
2	0.090	-0.080	10.622	0.005
3	0.001	0.010	10.622	0.014
4	0.151	0.194	12.161	0.016
5	-0.271	-0.171	17.218	0.004
6	0.036	-0.183	17.310	0.008
7	0.165	0.144	19.247	0.007
8	-0.111	0.041	20.139	0.010
9	-0.127	-0.154	21.333	0.011
10	0.017	-0.206	21.355	0.019
11	0.142	0.082	22.907	0.018
12	-0.382	-0.237	34.367	0.001
13	0.194	-0.058	37.382	0.000
14	0.043	0.052	37.537	0.001
15	0.032	0.093	37.622	0.001
16	-0.035	0.169	37.730	0.002
17	0.074	-0.077	38.212	0.002
18	-0.063	-0.205	38.562	0.003
19	0.009	0.076	38.569	0.005
20	-0.092	-0.072	39.359	0.006
21	0.090	-0.105	40.143	0.007
22	-0.033	-0.056	40.252	0.010
23	-0.056	-0.030	40.569	0.013
24	0.004	-0.085	40.570	0.019

Figure5..The.auto.correlation.(ACF).and.partial.auto.correlation.(PACF).at.the.first.difference

The.estimation.process.then.comes.to.select.the.most.appropriate.model.from.among.them.and.comparison.between.each.other..The.study.is.found.(1,.1,.12).the.best.of.them,.but.its.correlogram.of.the.residuals.is.not.flat.which.indicate.that.lag.9.has.some.information.that.must.be.captured.and.reestimation.was.conducted.again.by.adding.MA.(9).which.made.the.correlogram.of.the.residuals.is.flat..Thus,.the.AIRMA.model.(AR.(1).MA.(9).MA.(12)).the.most.appropriate.model.among.them.because.it.had.significant.coefficients,.lowest.volatility,.highest.AdjR2,.and.lowest.AIC.as.seen.in.the.above.Table.

Table.4..Selected.the.appropriate.arima.model.

ARIMA	(1.1.1)	(1.1.5)	(1.1.12)	AR(1).MA(9.).MA(12)
Significant.Coefficients	0	2	2	2
SIGMA2.(volatility)	7.39E+08	6.73E+08	5.63E+08	5.24.E+08
AIC	23.3920	23.307	23.1870	23.1751
Adj.R2	%11.79	%23.62	%32.79	%36.35

From.the.estimated.results.in.Table.5,.the.ARIMA.model.has.taken.as.following.formula..Also,.t-statistic.of.coefficient.was.written.under.each.its.corresponding.estimate.value.

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ΔWheatt.=.1786.655.0.42468
4.Wheatt.1.0.263094εt.8.0.549230ε.t
12.(1.72).(4.51).(1.092).(-2.27)

Table5..Estimation.results.of.the.ARIMA.model.for.Wheat.Production

Dependent.Variable:.D(WHEAT)				
Method:..ARMA.Maximum.Likelihood.(OPG.-.BHHH)				
Date:.04/29/24...Time:.21:02				
Sample:.1962.2022				
Included.observations:.61				
Convergence.achieved.after.26.iterations				
Coefficient.covariance.computed.using.outer.product.of.gradients				
.....Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	1786.655	1035.080	1.726104	0.0898
AR(1)	-0.424684	0.094082	-4.513963	0.0000
MA(9)	-0.263094	0.240797	-1.092599	0.2792
.....MA(12)	-0.549230	0.241737	-2.272013	0.0269
....SIGMASQ	5.24E+08	1.27E+08	4.133260	0.0001
R-squared	0.406013	Mean.dependent.var		1639.475
Adjusted.R-squared	0.363586	S.D..dependent.var		29933.98
S.E..of.regression	23880.00	Akaike.info.criterion		23.17519
Sum.squared.resid	3.19E+10	Schwarz.criterion		23.34821
Log.likelihood	-701.8433	Hannan-Quinn.criterion		23.24300
F-statistic	9.569550	Durbin-Watson.stat		2.044859
Prob(F-statistic)	0.000006			

Source:.Prepared.by.the.researcher.based.on.the.outputs.of.Eview12.

7.4..Diagnostics.Checking.

To.obtain.the.validity.of.the.model.for.prediction,.diagnostic.tests.of.the.model.were.conducted..In.this.aspect,.the.fit.model.ARIMA.(AR.(1).MA.(9).MA.(12)).model.passed.all.the.diagnostic.tests,.where.Q.statistic.of..Ljung.Box.for.all.the.24.lags.has.probability.values.greather.than.0.05.which.indicates.that.cant.not.reject.null.hypothesis.that.meaning.that.residuals.are.white.noise.as.shown.in.figure.6..Moreover,.the.value.of.the.Jarque.Bera.probability.was.(0.75).which.is.larger.than.5%..It.is.meaning.that,.the.residuals.of.the.model.follow.normal.distribution...Also.in.heterosceda sticity.test,.the.P.value.for.the.F.statistics.was.(0.0525).and.larger.than.5%,.thus.there.is.no.heteroskedasticity.in.the.model.

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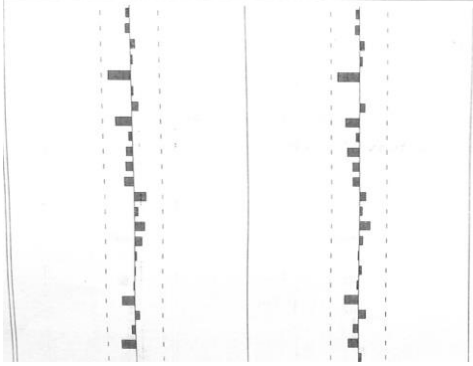
Correlogram of Residuals

Date: 04/27/24 Time: 23:01
Sample (adjusted): 1962 2022
Q-statistic probabilities adjusted for 3 ARMA terms



	Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1			-0.027	-0.027	0.0456	
2			-0.033	-0.034	0.1168	
3			0.047	0.045	0.2643	
4			0.023	0.025	0.3005	0.584
5			-0.200	-0.197	3.0503	0.218
6			0.017	0.007	3.0712	0.381
7			0.062	0.052	3.3470	0.502
8			-0.144	-0.130	4.8564	0.434
9			-0.031	-0.028	4.9280	0.553
10			-0.053	-0.108	5.1357	0.643
11			-0.061	-0.059	5.4201	0.712
12			-0.079	-0.061	5.9118	0.749
13			0.112	0.060	6.9221	0.733
14			0.036	0.032	7.0298	0.797
15			0.098	0.100	7.8323	0.798
16			0.066	0.039	8.2009	0.830
17			0.019	-0.002	8.2325	0.877
18			0.013	0.032	8.2472	0.913
19			-0.003	-0.009	8.2483	0.941
20			-0.114	-0.126	9.4632	0.925
21			0.048	0.069	9.6841	0.942
22			-0.028	-0.046	9.7601	0.959
23			-0.126	-0.095	11.374	0.936
24			0.003	0.028	11.375	0.955

Figure6..The.Correlogram.of.Residuals

In.figure7.through.the.inverse.roots.diagram,.it.is.shown.that.the.estimated.ARIMA.process.is.(covariance).stationary.because.there.is.no.AR.root.lies.outside.the.unite.circle..In.same.time,.there.is.no.MA.root.lies.outside.the.unite.circle,.thus.the.estimated.ARIMA.process.is.invertible.

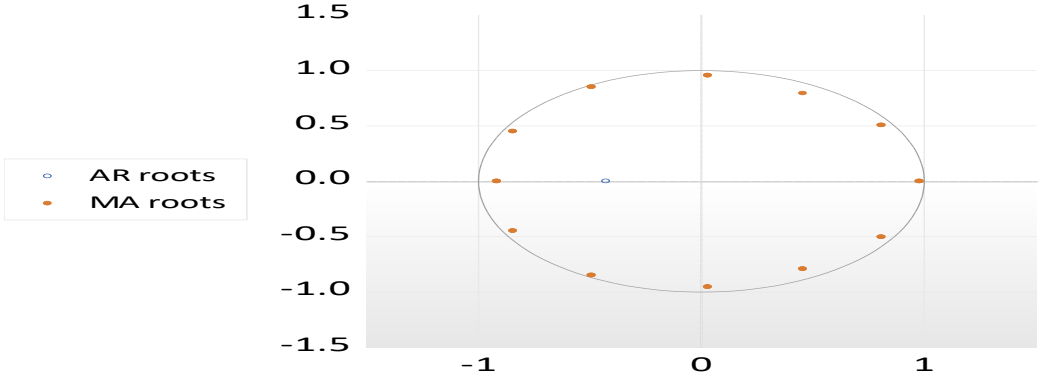


Figure7..Inverse.Roots.of.AR/MA.Polynomial(s).Specification:.D.(WHEAT).C.AR.(1).MA.(9).MA.(12).

7.5..Forecasting

Forecasting.is.the.main.goal.of.the.study.to.identify.future.wheat.production.in.Libya.and.accordingly.on.the.fitted.model.ARIMA.(Ar.(1),.Ma.(9),.and.MA.(12)).can.be.applied.in.order.to.forecast.of.wheat.production.process.after.passing.the.diagnostic.tests.during.the.next.six.years.(2023,.2024,.2025,.2026,.2027,.and.2028)..The.future.values.of.wheat.production.from.2023.to.2028.were.predicated.as.shown.in.Table.6..Also,.the.predict.power.of.this.model.is.strong.which.the.model.has.better.forecasting.ability.because.the.Thiel's.index.is.smaller.(23.31).

Table6..Future.value.of.Wheat.Production.Tons.(.2023.–.2028).

Years	2023	2024	2025	2026	2027	2028
Quantities	141 684 .9	143 471 .6	145 258 .2	147 044 .9	148 831 .5	150 618 .2

8.CONCLUSION

The.aim.of.the.study.was.forecasting.wheat.production.in.Libya.for.the.six.years.(2023.to.2028)..ADF.and.PP.stationarity.tests.indicate.that.the.wheat.production.series.is.stationary.at.the.first.difference..

The.fin.ing.of.the.Correlogram.at.the.first.difference.found.the.appropriate.number.of.autoregressive.terms.(".p").=.1.and.the.appropriate.number.of.moving.average.terms.Ma.("q").=12,.after.reestimation.found.the.ARIMA.....(AR.(1),.MA.(9),.MA.(12)).model.was.the.most.appropriate.model.among.the.selected.models.in.terms.of.significant.coefficients.numbers,.lowest.volatility,.highest.AdjR2,.and.lowest.AIC.criterion..As.for.diagnostic.test,.the.fit.model.successfully.passed.all.these.tests.and.did.not.suffer.from.any.statistical.problem,.such.as.Q.statistic.of.Ljung.Box.for.all.the.24.lags.had.probability.values.greather.than.0.05..Besides.that,.the.value.of.the.Jarque..Bera.probability.was.(0.75).which.is.larger.than.5%...Also.in.heteroscedasticity.test,.the.P.value.for.the.F.statistics.was.(0.0525).and.larger.than.5%..Moreover,.inverse.roots.diagram.showed.that.there.is.no.AR.root.lies.outside.the.unite.circle.and.there.is.no.MA.root.lies.outside.the.unite.circle..In.addition,.the.predict.po

wer.of.this.model.is.strong.which.the.model.has.better.forecasting.ability.because.the.Thiel's.index.is.smaller.(23.31)...The.study.finding.indicated.that.the.trend.of.wheat.production.during.2023-2028.will.be.increasing..

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