Research Journal of Biological Sciences 11 (3-6): 98-104, 2016
ISSN: 1815-8846

Model: Producer-Innovator, Farmers Technologies and Food Security in Rainfed Maize in Mexico Producers

[1]Miguel Angel Damian Huato, [1]Omar Romero Arenas, [2]Lucia Lopez-Reyes,
[2]Moises G. Carcano-Montiel, [3]Jose F. Conrado Parraguirre Lezama and [1]Artemio Cruz Leon
[1]Center of Agroecology, Institute of Meritorious, Benemerita University Autonomous Puebla (BUAP),
[2]Center of Microbiology, Institute of Sciences,
[3]Regional Unit Tetela, Benemerita University Autonomous Puebla (BUAP), Puebla, Mexico

Abstract: Productive-Innovative Model (MPI) is exposed to increasing corn yields in dry land. Its epistemic frame is crop management, rationalized in the dialogue of knowledge and biomimicry. Evaluates the use of innovations in the management of corn, identifies and groups the "maiceros" for their yields and raise the technological transfer pattern efficient to increase household food security. It was validated in Cohetzala and San Nicolas de los Ranchos, Puebla-Mexico where it was found that, corn converge in managing radical and progressive innovations in which prevail the second, presenting a statistical relationship with the performance, almost a third of producers are efficient, the handling of which is articulated to the agro-ecological approach, 15 and 57% of the corn growers of Cohetzala and San Nicolas have food security and if producers of low and medium income implement the MP-I, it would increase to 27 and 81% in Cohetzala and San Nicolas respectively.

Key words: Management corn, radical and progressive innovations, agro-ecology, knowledge dialogue, biomimicry

INTRODUCTION

The food is a right that is achieved with food security that is when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2006).

Corn is an essential well for Mexicans but for rural families is a special grain because biological and culturally have nurtured. It is exploited as use value by at least 41% of total of production units surveyed (5548.845) which were only produced for own consumption. This number reveals that maize accounts for Mexicans the well with the highest social use of the productive potential of human activity. The value used is the objective quality of wealth result of a useful work and a correct use. The utility (corn) is founded on the various needs (body, festive, symbolic) that satisfy (Garcia, 2009). For this reason, it is assumed that corn has been the basis of food security, especially since most of that is planted in dry land is managed as "milpa" (cornfields) that is associated with beans, squash, chili and many weeds. This polyculture provides food security to people with limited resources, biodiversity and genetic resources, traditional knowledge, cultural diversity, sustainability, economic viability and resilience and ecosystem services.

The relevance of corn is higher in states with less food security. SIAP (agriculture food and fishery information system) data (2016) and CONEVAL (2010) (Commission of Evaluation of social and development polices) (2010) show that in states where residents have less food security producers increased their absolute and relative contribution in planting corn (Table 1). Thus, while in 1980 these entities accounted 27.9% of total sown corn, 35 year later, this percentage increased to 35.4.

Achieving food security requires increasing yields per hectare. In rainfed maize this goal is a pending issue because in 35 year (1980-2014) the yield increased 660 kg, equivalent to 0.8% per year. In watering these numbers were, respectively 3.080 kg and 3.7% per year.

To reverse this trend intends to implement the MP-I which has as referring to technological pattern of efficient producers. Its epistemic frame is the management of maize, operationalized by reason of knowledge dialogue and the principle of biomimicry. In the management of maize production conditions influence general endogenous

Corresponding Author: Omar Romero Arenas,Center of Agroecology, Institute of Sciences,
Benemerita University Autonomous Puebla (BUAP), Puebla, Mexico

Table 1: Hectares planted and yield (kg ha^{-1}) of corn in dry land areas between 1980 and 2014 in entities with less food security

		Hectares planted		Yield (kg ha^{-1})	
Federal entity	Food security (%)	1980	2014	1980	2014
Chiapas	45.2	519,490	689,016	2,340	1,770
Guerrero	30.5	368,942	436,486	1,500	2,790
Oaxaca	47.9	413,117	542,242	1000	1,120
Puebla	46.2	494,694	509,595	1,680	1,600
Nacional	55.7	6,437,837	6,157,655	10,65	2,310

Based on data of SIAP 1980-2014 (2016) and CONEVAL (2010)

(climate, flora, etc.) and exogenous (public policies, family traits, etc.) immutable medium term and referred to specific factors involved directly in production. The way that producers combine these resources in the agricultural cycle specifically defines how to perform this operation. For this purpose it is run multiple tasks (plowing, planting, cultural practices, etc.) made at field level, applying radical innovations (hybrid, agrochemicals, etc.) or rural (native seeds, crop association, etc.) or a mixture of both.

The factors involved in the management it highlights the technology because it is the most effective way to improve the productivity of land and labor lever. Represents scientific knowledge applied to production materialized in objects (machines and devices) or management systems in economic activity (Katz, 1999). Innovation is to introduce significant technological changes (radical) or minor changes (incremental progressive).

The dialogue of knowledge refers to the simultaneous application in handling corn, traditional farming practices (progressive) and modern (radicals) invented and developed at different times. Biomimicry promotes agricultural practices that mimic the functioning of ecosystems and emphasizes the role of complementarity with all components of the agricultural system because only together it re-creates interactions and synergies that no isolation component can generate.

This study, is validated with producers of cohetzala and san nicolas de los ranchos, Puebla-Mexico, the innovations are evaluated applying in the management of maize and its impact on productivity, identifies, designs and characterizes the MP-I, key agro-ecological processes that define this model are analyzed, real security index is calculated in possessing households units as well as potential security index if less efficient producers apply the MP-I.

MATERIALS AND METHODS

Description of the study area: Cohetzala is southwest of the state of Puebla and has a warm semi-dry climate with summer rains it has regosols soils that are poorly developed and because they have gritty texture and small fragments of rock like the mother material from which it originates. In the municipality 1.308 ha were cultivated, 95% dry and maize covered 98.5% of the total planted area. San Nicolas de los Ranchos is located on the slopes of Popocatepetl. Its climate is cold with summer rains and soils predominate regosols. About 2,211 hectares of dry land were planted and the most important crop was corn with 61% of the total area.

The methodology consisted in five stages

Survey: It was designed and applied a questionnaire to a sample of producer members of the Programa directo de Apoyo al Campo (PROCAMPO) by its name in spanish, with questions referred the two conditions that influence the management of maize. The sample size was calculated (Cochran, 1977) it was estimated respectively, at n = 60 and 77 for producers to cohetzala and san nicolas. The survey data allowed.

Evaluate the radical and progressive innovations applied in the management of maize, according to calculation of the Index Appropriation of Radical Technologies (IATR) and the degree of use of progressive technologies (GETP) with the values obtained from the IATR and the GETP was prepared a typology of producers were classify into three categories: low (<33.33); medium (33.34-66.66) and high (>66.66).

Create a typology of producers according to their production potential. For this purpose, the major and minor corn producers performance were chosen whose difference was divided among three and the resulting quotient was adding to lower yields to build three ranges producers and create three types of producers: low (<33.33) medium (33.34-66.66) and high performance or successful (>-66.66). Characterize the technological pattern used by corn producers efficient handling of corn and types of producers as their production efficiency.

Calculate rates of real household food security and potential to estimate the amount of kilograms of maize in the less efficient producers will reduce their deficits this grain. To do the estimates relating to the proposed, it applied formula by Damian and Toledo (2016).

RESULTS AND DISCUSSION

Radical innovations and yields: Ownership Index Radical Technologies by its name in spanish (IATR) was calculated by comparing the technologies recommended for Instituto Nacional de Investigaciones Forestales,

Table 2: Technological pattern recommended by INIFAP for handling Cohetzala corn and San Nicolas de los Ranchos (SNR), Puebla-Mexico

Practice/Innovation	Recommendation
Cohetzala	
Sowing date	Between March-May
Seed type (Variety)	H-137, H-139, H-34, H-30, H-33, H-40, H-48, H-50, H-311, H-516, H-515, VS-536, H-507, H-509, V-524, VS-529 VS-22
Density of plants/a	50-60 thousand plants
Fertilizer formula	120-60-00, 100-50-00, 180-80-60
Date of fertilization	It is applied at planting and the second work
Name and dose of herbicide/ha	Gesaprim 50 (1 kg), 500 FW (1.5 L); Gesaprim 50 (1 kg) and Hierbamina (1 L); (1 kg), Basagran 480 (0.5 L); Marvel (1 L); Fitoamina 2.4 D (1 L), Hierbamina 2.4 D (1 L), Esterón 2.4 D (1 L)
Name and dose of insecticide/ha	Volaton al 2.5% (25 kg), Volaton 5% (12 kg), Furadan 5% (12 kg), Folimat 1000 (0.5 L); Parathion methyl 50% (1 L); Malathion (1 L); Sevin 80 (1 kg), Sevin 80% P H (1kg), Malathion 1000 E (1 L); Diazinon 25% (1 L)
San Nicolas de los Ranchos	
Sowing date	Between March-May
Seed type	H-30, H-33, H-34, H-40, H-48, H-50 H-137, H-139, VS-22
Density of plants (ha)	50 thousand plants
Fertilizer formula	140-60-00 y 110-50-00
Date of fertilization	Between the sowing and second work
Name and dose of herbicide (ha)	Gesaprim 50 (1 kg), 500 FW (1.5 L), Gesaprim 50 (1 kg) plus Hierbamina (1 L)
Name and dose of insecticide (ha)	Volaton 2.5%, Furadan 5% o Volaton 5% (12-25 kg), Folimat 1000 (0.5 L), Parathion (1 L) methyl 50% o Malathion (1 L) dissolved in 200 L of water per hectare

INIFAP, 2009

Table 3: Number of producers, IATR and yield (kg ha^{-1}) by type of producers Cohetzala (C) and San Nicolas de los Ranchos (SNR), Puebla-Mexico

	Low		Medium		Municipal average	
Municipalities/Indicator	Number	Percentage	Number	Percentage	Number	Percentage
C						
Producers	42	70	18	30	60	100
IATR	22.1		37.3		26.7	
Yield*	745^{a}		748^{a}		746	
SNR						
Producers	17	22	60	78	77	100
IATR	28.3		44.1		40.6	
Yield*	1359^{a}		1343^{a}		1347	

Prepared with data obtained from the survey, 2009: *Equal letters in mean yield, indicating no statistically significant difference (student t-test, $p<0.05$)

Table 4: Number of producers, GETP and yield (kg ha^{-1}) by type of producers Cohetzala (C) and San Nicolas de los Ranchos (SNR), Puebla-Mexico

	Low		Medium		High		Municipal average	
Municipalities/Indicator	Number	Perctange	Number	Perctange	Number	Perctange	Number	Perctange
C								
Producers	0	0	35	58	25	42	60	100
GETP	-		57.7		83.2		68.3	
Yield*	-		695^{a}		816^{b}		746	
SNR								
Producers	9	12	37	48	31	40	77	100
GETP	20		54.1		81.9		61.3	
Yield*	778^{a}		1285^{b}		1585^{c}		1347	

Prepared with data obtained from the survey, 2009; *Letters different in average yield, indicates statistically significant difference (student's t-test $p<0.05$)

Agricolas y Pecuarias (INIFAP) for management of corn, (Table 2) versus management practices made by producers. It is assigned a nominal value of 100 units to the technological package and was weighted considering the impact of each technological component in the productivity of maize 10 for the planting date, 20 for variety, 15 for population density, 25 and 5 for the fertilization and fertilizer application date, 6 and 4 for the type and dose of herbicide, 6 and 4 for the type and dose of insecticide and 5 for combating diseases.

It was found that the INR is low and differential (Table 3) especially, in Cohetzala where it was applied only 24% of the recommended innovations from INIFAP there was no significant relationship between the use of these technologies and performance ($n = 144$, $r = 0.0155$, $p = 0.8789$) and no significant statistical difference between the average yield of the corn growers low and medium appropriation ($t = -0.6930$, $p = 0.4900$).

It was estimated employment Grade of Technologies Progressive by its acronym in spanish (GETP) being found that in maize management predominate progressive technologies (Table 4) especially where GETP Cohetzala average was >41.6 units IATR. In addition, it were found statistically significant differences between the average

Table 5: Number of producers, IATR, GETP and yields (kg ha^{-1}) of Cohetzala (C) and San Nicolas de los Ranchos (SNR), Puebla-Mexico, according to production efficiency

	Low		Medium		High		Municipal average	
Municipalities/Indicator	Number	Percantange	Number	Percantange	Number	Percantange	Number	Percantange
C								
Producers	14	23	27	45	19	32	60	100
IATR	19[a]		25[b]		25[b]		24	
GETP	63[a]		72[b]		73[b]		70	
Yield	486[a]		751[b]		930[c]		746	
SNR								
Producers	27	35	28	36	22	29	77	100
IATR	37[b]		32[a]		37[b]		36	
GETP	59[a]		66[b]		74[c]		66	
Yield	763[a]		1438[b]		1,971[c]		1.347	

Prepared with data obtained from the survey, 2009; *In each row (yield, IATR and GETP), different letters in the middle indicates statistically significant difference (Tukey test, $p<0.05$)

Table 6: Innovations used in the management of maize by efficient producers in Cohetzala and San Nicolas de los Ranchos, Puebla-Mexico

Municipality/activities (%)	Practices/technologies
Cohetzala	
Soil conservation	Soil conservation fence (21). Do not apply soil conservation techniques (79)
Sowing date	June (74); July (26)
Seed variety	Natives (100)
Plant density (ha)	50.781
Crop association	Corn associated with: bean-squash (74), beans and jamaica (5), Jamaica (21)
Crops rotation	Were alternated with: sesame-jamaica (11); jamaica (26) and sorghum (5). Were not alternated crops (58)
Manure application (kg ha^{-1})	1.754 applied before planting
Fertilization formula	8 predominating formulas were applied: 92-00-00 (26); 115-00-00 (21); other formulas (53)
Name and dose of herbicide	Esteron 1 L ha^{-1} (5); Gesaprim 1 kg ha^{-1} (5), Doesn't know (6); Tordon 2 L ha^{-1} (5); were not apply (79)
Name and dose of insecticide	Folidol 1 L ha^{-1} (11), "gallito" (comercial name) 1 L ha^{-1} (5); does not apply (84)
San Nicolas de los Ranchos	
Soil conservation	Soil conservation fence (18), live terraces (23) and trenches (9). Were not apply soil conservation techniques (50)
Sowing date	March (77) and April (23)
Seed variety	Natives
Plant density (ha)	67,900
Crop association	Corn associated with: fruit and beans (32), fruit-pumpkin (4) and beans (14). Were not associated crops (50)
Crops rotation	Alternating with barley (23), beans (27), bean (14) and wheat (4). Were not alternated crops 32
Manure application (kg ha^{-1})	1,383 applied before planting
Fertilization formula	Were applied seven predominating formulas: 69-00-00 (36), 92-00-00 (18), 46-00-00 (14) and other formulas (28). No apply fertilizers (4)
Name and dose of herbicide	Esteron L ha^{-1} (14), Gesaprim 1 kg ha^{-1} (22), Hierbamina 1 L ha^{-1} (13) and other insecticides (7). Were not applied herbicides (44)
Name and dose of insecticide	Volaton 2.5%, Furadan 5% o Volaton 5% (12-25 Kg); Folimat 1000 (0.5 L); Parathion (1 L) methyl 50% or Malathion (1 L) dissolved in 200 L of water per hectare.

Prepared with data obtained from the survey, 2009

performance of the producers of medium and high GETP ($t = 2.8103$, $p = 0.0064$) of Cohetzala and between medium and high GETP ($t = 2.0350$, $p = 0.0155$) San Nicholas.

Product-innovator model: In applying the methodology found that in cohetzala the lowest and highest yields were 400 and 1000 kg per hectare the difference was 600 the quotient value was 200 and corn producers ranges for low, medium and high yield were respectively, <600, between 601-800 and >800 kg ha^{-1}. These numbers for San Nicolas were respectively 500 and 2.200 1,700, 567, <1.067, 1.068, -1.635 and >1.635.

The findings show (Table 5): all producers applied the knowledge dialogue in handling the corn almost a third of polled were efficient producers the difference in yields was significantly higher among producers of medium and low yields hat among high compared to average (Tukey test $p<0.05$) and increased IATR not reflected in higher yields ($n = 144$, $r = 0.0908$, $p = 0.4324$) but greater GETP performance was significantly higher ($n = 144$, $r = 0.4621$, $p<0.0001$).

Characterization of technological model of efficient producers: The technological standard of efficient producers corroborates the relevance of progressive innovations in handling maize (Table 6). If this pattern is compared with that recommended by the INIFAP are noticed large discrepancies between them.

The INIFAP recommended planting hybrids and most native seeds cultivated corn producers because prefer to make tortillas have an ancient adaptation to local agro-ecosystems have a stable productivity over time and are pillars of livestock breeding that provides agriculture

Table 7: Socioeconomic features and availability to means of production, according to the performance and producers of Cohetzala and San Nicolas de Los Ranchos, Puebla-Mexico

Municipalities/Indicator	Low	Medium	High	Municipal average
Cohetzala				
Age (years)	54.8	57.8	52.6	55.5
Remittances ($ average/month/per capita)	475	607	474	534
Average cost ($/month/per capita)	927	1.1	1.0	1.0
Corn consumption (%)	100	89	68	83
Consumption and sale of maize (%)	0	11	32	17
Primary pluriactive* (%)	43	67	95	70
Secondary pluriactive** (%)	29	15	5	15
Maicero*** (%)	28	18	0	15
Corn planted area (average ha)	2.1	2.3	2.5	2.3
Possession of tractor (%)	14	15	5	7
Possession of yoke (%)	71	70	84	75
Older livestock (number heads/average)	4.5	6.1	5.8	5.6
Small livestock (number heads/average)	10.6	18.2	19.3	16.8
San Nicolas de los Ranchos				
Age (years)	58.5	52.4	52.1	54.5
Remittances ($/month/per capita)	112	94	91	100
Average cost ($/month/per capita)	726	657	648	677
Corn consumption (%)	78	36	9	43
Consumption and sale of maize (%)	22	64	91	57
Primary pluriactive* (%)	15	64	100	57
Secondary pluriactive** (%)	70	25	0	34
Maicero*** (%)	15	11	0	9
Corn planted area (average ha)	2.3	2.8	3.6	2.8
Possession of tractor (%)	7	7	18	10
Possession of yoke (%)	43	54	77	57
Older livestock (number heads/average)	1.2	2.2	6.9	3.2
Small livestock (number heads/average)	9.8	12.4	23.3	14.6

Prepared with data from the survey, 2009. *Producers who cultivated corn and performed other tasks in economic branches of the primary sector. **Were carried out other activities in the secondary and tertiary sectors. ***Includes only planted corn producers

manure and draft power. The agricultural chemical fertilizer used most often was although, lower than those recommended by INIFAP, especially in San Nicolas de los Ranchos dose. In Cohetzala, the doses of fertilizers were higher on the soil (regosols) predominate which are incipient formation and low fertility.

Another agrochemical usually employed in handling the corn is the herbicide, substitute of labor. The exclusion of small producers of public policy has caused emigration and senescence of the rural population and rising labor. Of the total members of the families of producers Cohetzala (328 people), 47% emigrated and their average age was 55.5 year. San Nicolas de los Ranchos, these data were respectively 434, 20% and 54.5. The agrichemical lest commonly used was the insecticide. Herrera refers to the diversity and abundance of arthropod fauna is higher in polyculture than in monocultures, promoting the emergence of chains and food webs which inhibits the damage caused by pests.

There are three activities (soil conservation, crop association and rotation) and two inputs (native seed and manure), the INIFAP not consider in its technological recommendation even when the applied massively by corn producers. The evidence found in this study (Table 4-6) indicate that in the management of rainfed maize, prevails the dialogue of knowledge where they interact as already stated, two cultural forms of knowledge, predominantly progressive peasant origin which are articulated in to agro-ecological science.

Agroecology and management of corn: To Garrido (2011) epistemology of agroecology is the creative application of the principle of biomimicry in the design of agro(eco)systems which is achieved exclusively by the use of farming technologies, especially by polyculture since re-create a plant structure consisting of several "floors" as natural ecosystems, causing greater biodiversity of flora and fauna up-down and inside-soil around the agricultural ecosystem.

Altieri and Nicholls (2007) suggest that intercropping systems and agroforestry, mimic natural processes and ensure that efficiency is attributed to the complementarity established between biotic and abiotic components interact in the agroecosystem become synergies. As agro-ecosystems management (biomimesis) comprises agricultural practices to improve agricultural systems by imitating natural processes, creating beneficial biological interactions and synergies between the components of the agroecosystem (Schutter, 2010).

Biomimicry was applied for 100% of the corn growers in Cohetzala and 50% of San Nicolas, it was handled corn associated with other crops, re-creating greater biodiversity which resulted in more unit yields. As it is known in this biodiversity, interact C4 plants (maize) and C3 (beans, squash, weeds) that require different intensities of heating to transform inorganic compounds into organic energy. In addition, they plants associated with different root systems so they do not establish nutrient competition with each other unlike, he presence of legumes in association capture nitrogen, a nutrient essential for macro-nutrition of plants. At the same time, greater biodiversity favors the creation of trophic networks that inhibit the damage they can cause organisms to agroecosystem. Similarly, greater biodiversity creates more biomass below ground and a greater abundance and richness of microorganisms responsible for degrading the organic matter and recycle nutrients and energy.

Types of producers and production efficiency: The attributes of efficient corn producers, compared to less efficient (low and medium) is shown in Table 7 where it is observed that:

- It has on average younger age, more subtly accessing workforce management since corn is more intensive polyculture in this resource
- Have lower incomes and remittances
- They are more receptive to technical advice

Have diversified their tasks in the primary sector related to the handling of corn and less efficient in the secondary and tertiary sectors, especially those of San Nicolas for its proximity to the metropolitan area of Puebla. Pluriactivity is an effective survival strategy for rural households (Vernimmen *et al*., 2002). But other studies (Anseeuw and Laurent, 2007) have noted that households have diversified their income have reduced their agricultural income because multiactivity causes less specialization and greater technological regression that is going to revealed in lower unit yields.

It has less availability of agricultural machinery and more yoke, making it the industry 35-49% of cattle in Cuetzalan and San Nicolas respectively, safeguarding agriculture-livestock, creator of unique synergies in the management of maize relationship.

Revert low yields of less efficient corn producers requires reducing the technology gap by reason of the transfer of MP-I. Only thereby decreasing its deficit performance and increase food security.

Real household food security and potential: The family structure of respondents was 328 corn growers Cohetzala and 401 people in San Nicolas. In estimating the actual household food security, considering a consumption of 500 kg per year, it found that 15 and 57% of people Cohetzala and San Nicolas, respectively, achieved food security each family member in Cohetzala has on average a year, 339 kg of maize and 726 in San Nicholas each person with food security in Cohetzala produces an annual surplus of 231 kg and 767 San Nicholas to sell at local markets and/or regional. In contrast those who do not have food security in Cohetzala have to buy on the market 229 kg per year of corn, 46% of total maize consuming. These data for San Nicolas de los Ranchos are 253 kg and 51%, respectively.

If the MPI of Cohetzala is transferred to the low and medium potentially yields grow on average, 60-24%. Estimating potential food safety it was found that 27 and 81% of people Cohetzala and San Nicolas respectively would achieve food security each family member in Cohetzala would have an average of 415 kg of corn and San Nicolas de los Ranchos 1035 kg the yield gap of 231 kg to achieve food security in Cohetzala would drop to 189 kilograms and 227 San Nicholas.

Pretty *et al.* (2011) evaluated 40 projects from 20 African countries crop management intensified during 2001-2010 by improving harvests the integrated fight with pest control, soil conservation and agroforestry. In 2010, the average yield is multiplied by 2.13 increased the total food production by 5.8 million tons per year = 557 kg per family/year. The movimiento campesino a campesino increased maize yields half a ton per hectare to three as a result of manufacturing compost to make rotations with legumes and sandwiching new crops in arid plots of Vicente Guerrero in the municipality of Espanita, Tlaxcala-Mexico.

CONCLUSION

Final thoughts: The evidence suggests that most producers of upland apply a dialogue of knowledge and the principle of biomimicry in handling the corn where peasant innovations prevail. It also indicates that this management is differentiated where converge producers with different production capacities, highlighting efficient whose management is articulated to agroecology which has recreated a top-down functional diversity of soil and in-around agro-ecosystems from which they derived the higher unit yields. These "new" forms of management are available among the peasants sufficient to identify and transfer less efficient to strengthen the supply of corn and household food security of the poorest of Mexico producers. The MPI can be applied to the study of the general and specific conditions that influence the management of other agricultural systems and other spatial contexts. The two conditions that is required to be performed locally and similar agricultural systems are compared: and temporal versus temporary irrigation versus irrigation.

ACKNOWLEDGEMENT

To the National Council of Science and Technology and the Autonomous University of Puebla for financing granted to perform this research.

REFERENCES

Altieri, M.A. and C.I. Nicholls, 2007. Biodiversity and Pest Management in Agroecosystems. Vol. 2, Icaria Editorial SA., Barcelona, Spain,.

Anseeuw, W. and C. Laurent, 2007. Occupational paths towards commercial agriculture: The key roles of farm pluriactivity and the commons. J. Arid Environ., 70: 659-671.

CONEVAL., 2010. [National council for the evaluation of social development policy 2010 income poverty in Mexico]. Mexico.

Cochran, W.G., 1977. Sampling Techniques. 3rd Edn., Willey Eastern Ltd., New Delhi, India, ISBN: 0852261217, Pages: 428.

Damian, H.M.A.Y.V. and M. Toledo, 2016. Utopistica Agroecologica: Peasant Innovations and Food Security in Maize. 1st Edn., Editorial Promotion-BUAP, Puebla, Mexico, ISBN: 978-607-487-999-5, Pages: 130.

FAO., 2006. Eradication of hunger in the world: Assessment of the situation ten years after the World Food Summit. Rome, Italy.

Garcia, A., 2009. Forma Valor Y Forma Comunidad: Aproximacion Teorica-Abstracta a Los Fundamentos Civilizatorios Que Preceden al Ayllu Universal. CLACSO, La Paz, Bolivia,.

Garrido, F., 2011. Political ecology and agroecology: Cognitive frameworks and institutional design. Agroecology J. Agroecology, 6: 21-28.

Katz, C., 1999. Technology as a social productive force: Implications of a characterization, Quipu. Latin Am. J. Hist. Sci. Technol., 12: 371-381.

Pretty, J., C. Toulmin and S. Williams, 2011. Sustainable intensification in African agriculture. Intl. J. Agric. Sustainability, 9: 5-24.

Schutter, O.D., 2010. Report submitted by the special rapporteur on the right to food. United Nations, General Assembly, Switzerland.

Vernimmen, T., M. Bourgeois, G.V. Huylenbroeck, H. Meert and E.V. Hecke, 2002. Diversification as a survival strategy for marginal farms an exploratory research. Proceedings of the Xth EAAE Congress on Exploring Diversity in the European Agri-Food System, August 28-31, 2002, EAAE, Zaragoza, Espana, pp: 1-15.